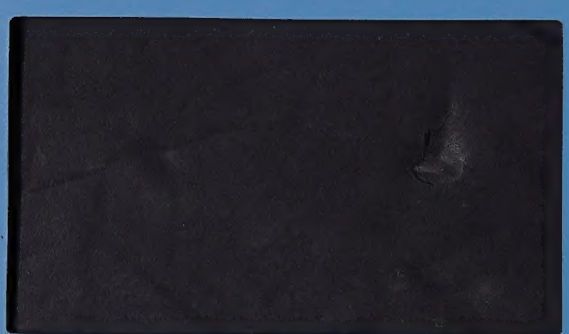
INSTRUCTION MANUAL

Type RM527

Waveform Monitor

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES



INSTRUCTION MANUAL

Type RM527 Waveform Monitor

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

Tektronix International A.G.
Terrassenweg 1A ● Zug, Switzerland ● PH. 042-49192 ● Cable: Tekintag, Zug Switzerland ● Telex 53.574

070-296

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

Copyright © 1961 by Tektronix, Inc., Beaverton, Oregon. Printed in the United States of America. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

CONTENTS

Warranty

Section 1 Characteristics

Section 2 Installation Instructions

Section 3 Operating Instructions

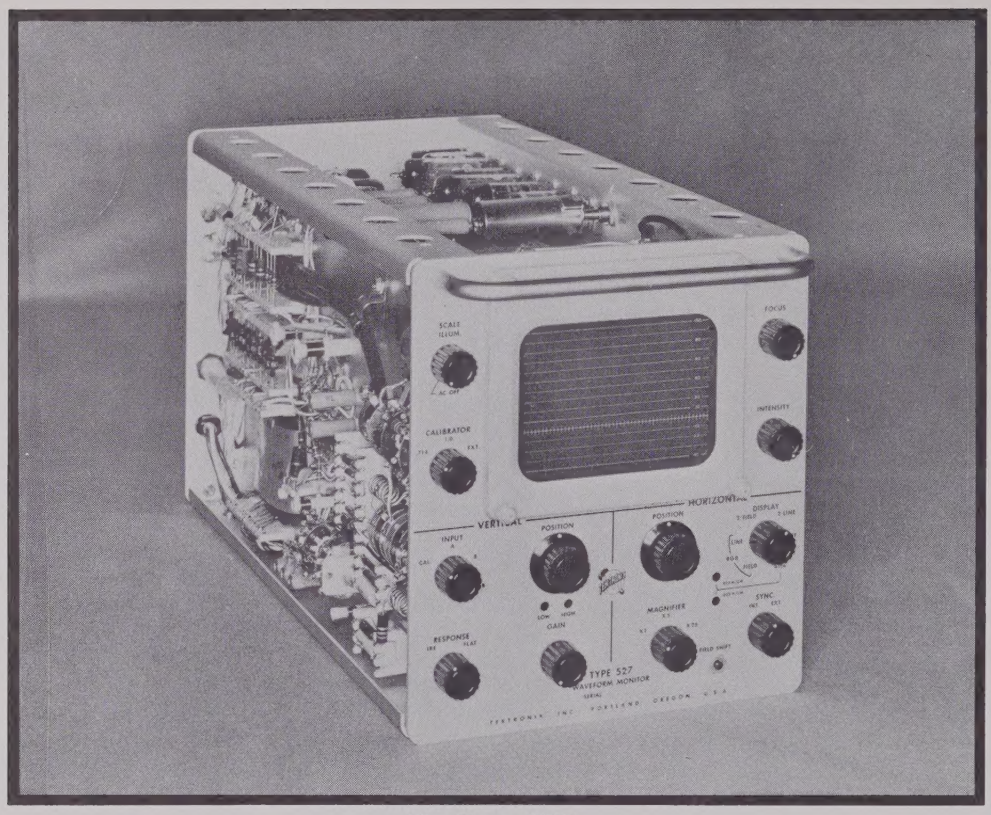
Section 4 Circuit Description

Section 5 Maintenance

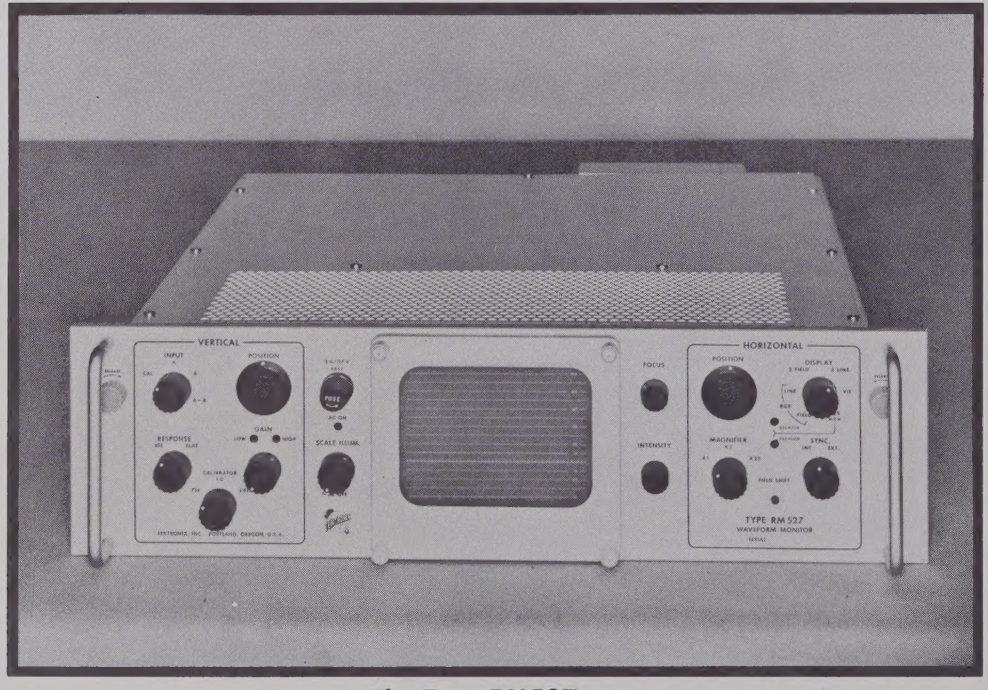
Section 6 Calibration

Section 7 Accessories

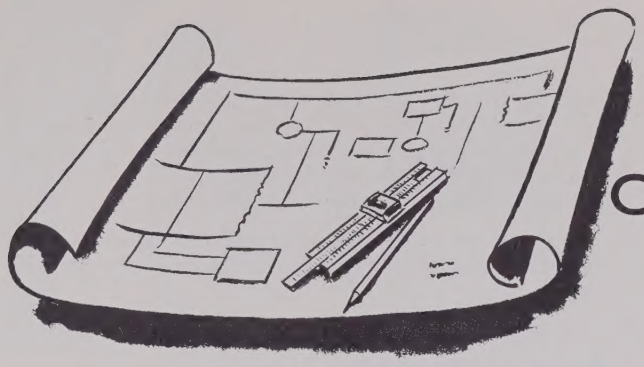
Section 8 Parts Lists and Diagrams



The Type 527



The Type RM527



SECTION 1

CHARACTERISTICS

General Information

The Tektronix Type 527 Waveform Monitor is a portable, self-contained cathode-ray oscilloscope specifically designed for video-waveform monitoring at television transmitters and studio facilities. With this monitor, any portion of the television-signal waveform can be displayed on a 5-inch rectangular crt. Two Type 527 monitors may be cradle-mounted side-by-side in a rack or console.

The Tektronix Type RM527 Waveform Monitor has the same electrical characteristics as the Type 527 except that the physical layout of parts has been arranged to provide minimum height and maximum convenience in a rack-mounted installation. Since the two instruments are similar, the "Type 527" designation is used to describe both instruments in this manual. Important differences, where they occur, will be pointed out.

The vertical amplifier is provided with a network that can be switched in to limit the high-frequency response to that recommended by the IRE Standards Committee for standardized pulse-level measurements. A second switch position adds high-frequency compensation to make the frequency response flat to 5 mc, ±1%.

An internal 30-kc amplitude calibrator provides 0.714-volt or 1.0-volt pulses for calibrating the vertical amplifier. The sweep system provides calibrated sweeps which eliminate the need for time markers.

VERTICAL DEFLECTION SYSTEM

Deflection Factor

Continuously variable from 0.25 volt to 1.6 volts for 140 IRE units (7 centimeters of vertical deflection).

Frequency Response

Flat — 60 cycles to 5 mc, ±1%.

IRE — 1958 Standard 23S-1.

Linear Deflection

Linear within 1% on the screen.

DC Restorer

Back-porch clamping; does not affect the color-burst signal.

Signal or Video Inputs

Two bridged 75-ohm compensated signal inputs provided. Either signal input may be monitored or a balanced (differential) input between both may be used.

Input Impedance

1 megohm paralleled by 20 pf.

HORIZONTAL DEFLECTION SYSTEM

Calibrated Sweep Rates

0.125H/CM, 0.025H/CM with X5 Magnifier, and 0.005H/CM with X25 Magnifier. Accuracy in both magnifier positions is within 3%.

Uncalibrated Sweep Rates

Half-line rate or H/2 and field rate or V/2 for conventional displays, 1000-microsecond sweep triggered at the frame rate for VIT displays, and special line- and field-rate sweeps for RGB displays.

DC Unblanking

The dc-coupled unblanking pulse permits the slowest sweeps to be used with uniform spot intensity throughout the sweep.

CPXR

Connector provided for 20-cycle staircase CPXR signal for use in conjunction with certain color-television video processing amplifiers.

SYNC REQUIREMENTS

Internal

Sync obtained from vertical amplifier. Sync derived from channel A when using A-B differential input.

External

0.5-volt minimum composite video or 3.5 to 8 volts composite sync signal. Two coax connectors are provided so that a 75-ohm line may be bridged or looped through the Type 527. Inductive compensation is provided for 20-pf loading capacitance in the loop-through. Input resistance is 800 k or higher. INT.-EXT. SYNC. switch selects either internal or external sync.

AMPLITUDE CALIBRATOR

Frequency

Approximately 30 kc.

Amplitudes

Three-position front-panel control selects either a 0.714-volt or 1.0-volt, peak-to-peak, ±1%, internal calibrator signal, or an external calibration signal (0.25 to 1.6 volts).

OTHER CHARACTERISTICS

Cathode-Ray Tube

Tektronix Type T527P1 crt is normally supplied unless another phosphor is specifically ordered. The crt is a flat-faced 4" x 5" rectangular crt operating at 4 kilovolts accelerating potential. Calibrated viewing area is 7 by 10 centimeters. Alignment of the trace and graticule is provided by an electrical beam rotator.

Standard Graticule for Composite Video Level Measurements

Illumination — Variable edge lighting.

Display Area — 7 centimeters high by 10 centimeters wide. Scribed on back surface at every 10 IRE units; the —40, 0, +7.5 or +10, and +100 are more heavily scribed than the others. The —40 marking represents the sync-tip level, the "0" marking (marked in centimeter and 2-millimeter divisions) represents the blanking pulse level, and the +100 marking represents the maximum white level.

Other graticules for noncomposite video signals and percentage video modulation are available at slight additional cost.

Power Requirements

105 to 125 volts or 210 to 250 volts, rms, 50-60 cycles. Approximately 206 watts at 117 volts, 60 cps. Refer to Power Transformer Connections in Section 2 of this manual for details on operation at line frequencies higher than 50 to 60 cycles.

MECHANICAL CHARACTERISTICS

Ventilation

Forced-air cooling.

Finish

Photo-etched, anodized front panel.

Dimensions

Type 527 — 9 9/16" high, 8 1/2" wide, 18 3/4" deep (overall).

Type RM527 — 5 1/4" high, 16 3/4" wide (excluding front panel), 18 1/4" deep (overall). Fits standard 19-inch rack.

Net Weight

Type 527 — Approximately 27 pounds.

Type RM527 — Approximately 30 pounds.

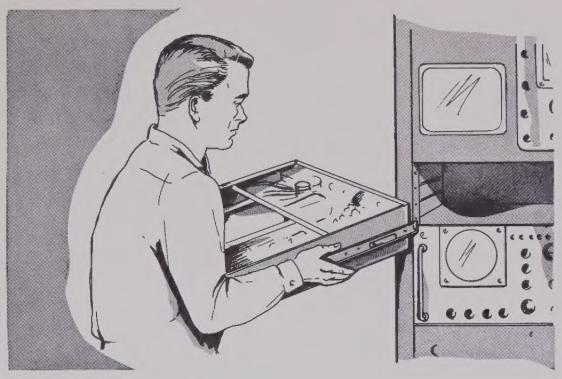
Accessories

1—3 to 2-wire adapter, 103-013

1—Graticule, 331-069

1—Green filter, 378-525

2—Instruction manuals



SECTION 2

INSTALLATION INSTRUCTIONS

Cooling

A fan maintains a safe operating temperature, providing the inlet air temperature does not exceed approximately 45° C (113° F). Under no circumstances, during operation, should the air flow be restricted or obstructed.

Chassis arrangement in the Type 527 (standard version) forms a duct which directs the air flow around the components. This arrangement allows adequate air circulation during normal operation of the instrument with or without the use of the field case (optional accessory).

To assure proper air circulation in the Type RM527 (rack-mount version), the top dust cover must be in place to direct the air flow to the Vertical Amplifier tubes.

Oiling instructions for the Muffin Fan will be found in Section 5 of this manual.

Radiation

To prevent high-voltage power-supply radiation of 30-kc fundamental and harmonic frequencies from affecting adjacent instruments in the rack, it is important to keep the high-voltage shield in place on the Type 527. To shield the Type RM527 radiation, keep the bottom dust cover in place.

Power Transformer Connections

The power transformer T601 is wound with two 117-volt primaries. When the instrument leaves the factory, the primaries are ordinarily connected in parallel for 105- to 125-volt, 50- to 60-cycle operation. If operation from 210- to 250-volt, 50- to 60-cycle lines is desired, remove the jumpers connecting terminals 1 and 2 and terminals 3 and 4. Then connect a jumper between terminals 2 and 3. With the line still connected to terminals 1 and 4, the instrument is ready for 210- to 250-volt operation. Fig. 2-1 shows the transformer connections required for each range of operation.

Since the ac fan motor is connected across only one of the transformer primaries, no change in ac fan motor lead connections is required for 50- to 60-cycle operation. When the transformer connections are changed, the metal tag fastened near the power cord should be reversed and marked to indicate the new operating voltage.

The line frequency range at which the instrument can operate is limited by the fan motor—the fan is designed for 50- to 60-cycle operation only. If the line frequency in your area is above 50 to 60 cycles, you must make other provisions for cooling the instrument. Cooling requirement of the instrument, with an ambient temperature not exceeding 45°C, is 100 cu ft/min of air.

At a line frequency of 400 cps, the nominal operating voltage and regulating range is about 3% higher than at 50 to 60 cps. At a line frequency of 800 cps, the nominal operating voltage and regulating range is about 5% higher than at 50 to 60 cps.

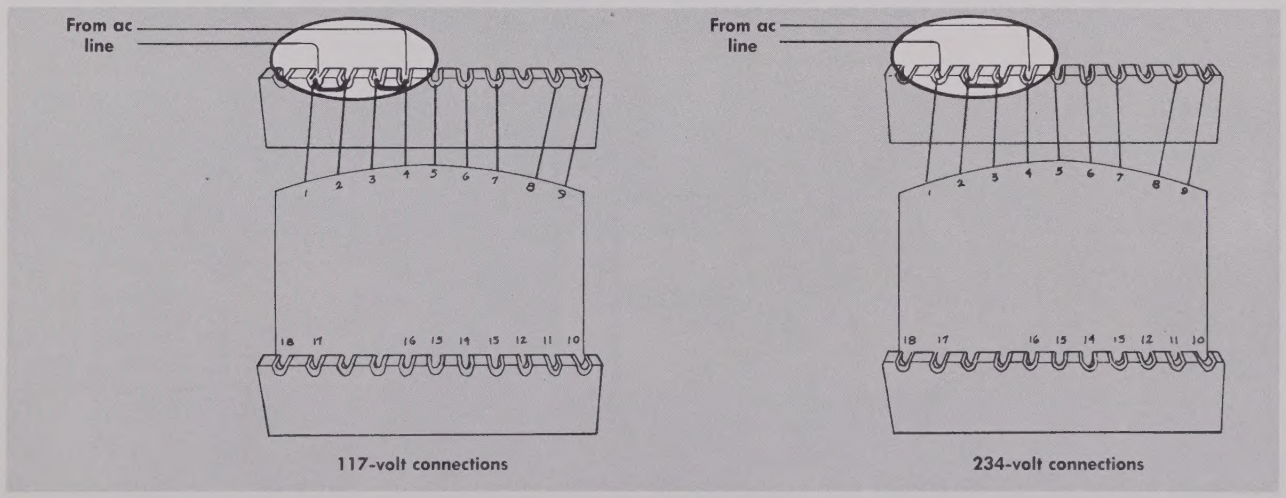


Fig. 2-1. Line transformer connections for 117- and 234-volt operation.

For maximum dependability and long life, the line voltage applied to the instrument should be near the design center (117 or 234 volts). If the line voltage falls outside of the operating limits or has a poor form factor (clipped sine-wave peaks) unstable power supply operation may result. Observe with a test oscilloscope for power line voltage and waveform before checking for other causes of unstable operation.

Fuse Requirements

When the instrument is connected for 117-volt operation, use a 3-amp fast-blowing type fuse. When the instrument is connected for 234-volt operation, use a 1.5-amp fast-blowing type fuse.

Installing the Type 527 (Standard Version)

The Type 527 is designed to be cradle-mounted in a standard 19-inch rack or console side-by-side with another Type 527, or with a commercial 8-inch picture monitor. Provision should be made for cool air inlet and power- and signal-cable connections at the rear of the instrument.

Dimensions of the Type 527 are shown in Figs. 2-2, (a) and (b). The cradle mount which holds a commercial 8-inch picture monitor is used to hold the Type 527. Four threaded 10-32 holes are provided in the bottom of the Type 527 so that the instrument may be securely fastened to the cradle-mount shelf. These same holes may be used to fasten the field case to the instrument. Fig. 2-2(c) shows the hole location requirements for the cradle-mount shelf. 1/4-inch spacers are supplied with the Type 527 to raise the instrument above the front lip on the shelf for a snug fit against the mask or bezel.

Three special cradle assemblies are available as optional accessories for use with the Type 527. These assemblies provide (a) side-by-side mounting of two Type 527's; (b) one Type 527 mounted on the left side of the monitor; and (c) one Type 527 mounted on the right side of the monitor. See your local Field Engineer before ordering.

If desired, the Type 527 may be removed from the console and slipped into a field case for portable use. The field case is available as an optional item. The dimensions of the case are: $9^{15}/_{16}$ inches high, $8^{7}/_{8}$ inches wide, and $17^{13}/_{16}$ inches deep (overall).

Type RM527 Rack-Mounting Information

In the same space required to mount two Type 527's side-by-side, two Type RM527's may be mounted one above the other in the rack or console. Chassis-Traks are provided for mounting the Type RM527.

The Chassis-Traks are designed to fit EIA standard rack or console rail hole locations. When installed, they permit the instrument to be pulled out of the rack or console to the fully extended position and tilted backward about 100° for convenient servicing. Stop latches (fastened to the inner slides) prevent the instrument from falling out of the intermediate sections of the Chassis-Traks.

The instrument may be removed from the intermediate sections to a work bench by depressing the stop latches and pulling the instrument forward. To return the instrument to the rack, the stop latches are depressed once to slide the instrument into the intermediate sections and then depressed again to move the instrument past the fully extended position. When the instrument is in the fully closed position, panel lock knobs permit locking the instrument to the rack rails.

In selecting a location for mounting the Type RM527, allow provisions for cool air inlet and power- and signal-cable connections at the rear of the instrument. In addition, allow 3 to 4 feet clearance in front of the rack so you can extend the instrument fully out of the rack or console on the Chassis-Trak slides for maintenance or operational purposes. This amount of clearance will permit you to tilt the instrument in the Chassis-Traks, and still allow working room in front. Mounting and clearance dimensions are shown in Fig. 2-3.

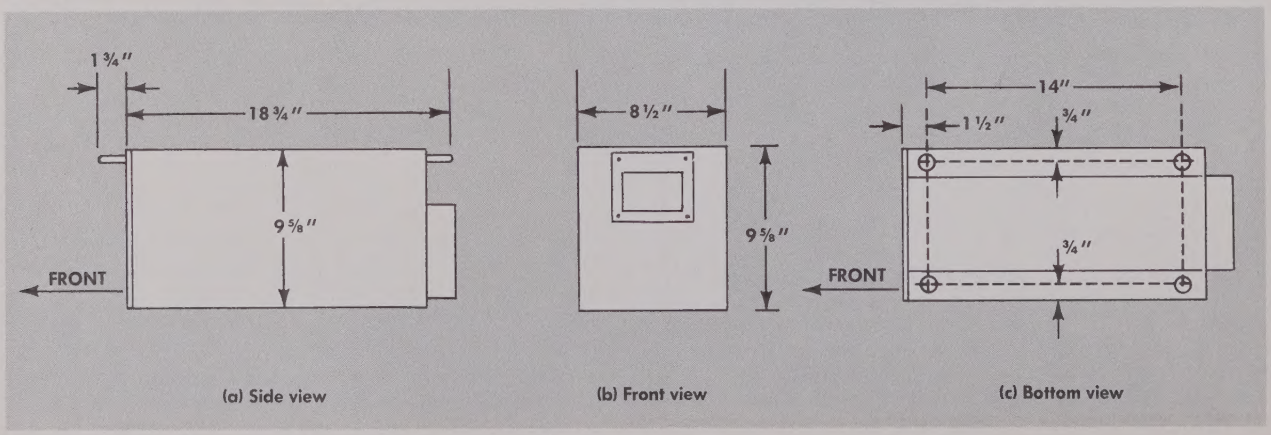


Fig. 2-2. Type 527 (standard version) dimensions and location of mounting holes.

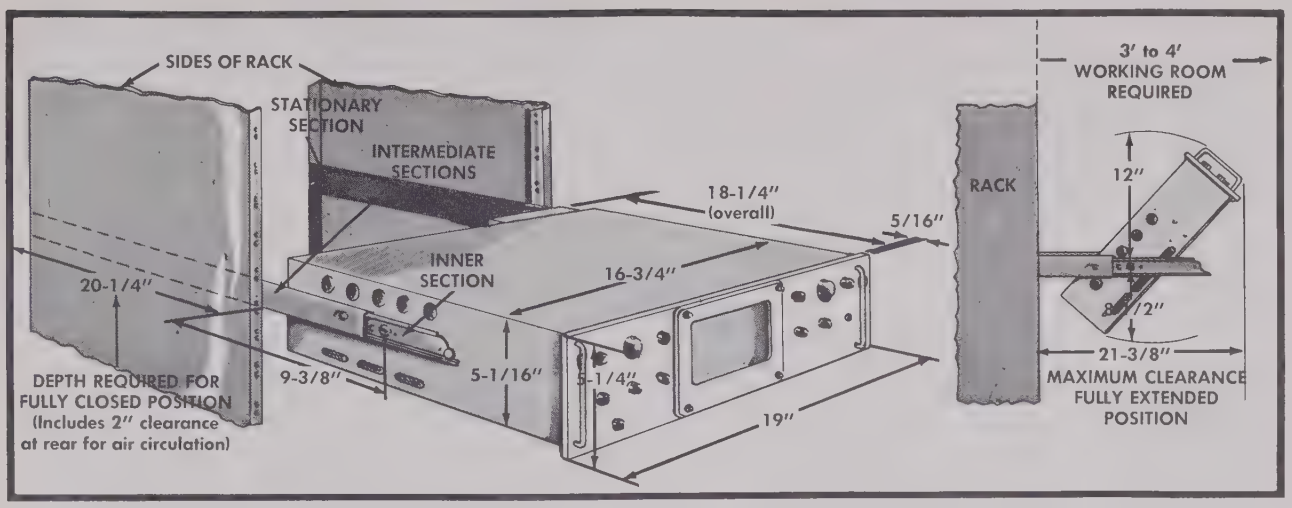


Fig. 2-3. Type RM527 mounting dimensions.

Sometimes it may be desirable or necessary to operate your Type RM527 in the fully extended position. In such cases you must consider the extra cable lengths needed to operate the instrument.

Mounting the Type RM527

1. Mark a point on the front of the left-hand rack rail where you want to position the top of the front panel. Mark a second point 2 inches below the first mark. The center of the upper mounting screw should fall on the second mark and on a rail mounting hole (see Fig. 2-4).

2. Using two 10-32 BHS screws, loosely fasten the grooved 10-32 bar nut to the rail at the upper and lower mounting hole locations. The upper screw goes in the hole found in Step 1 and the lower screw goes through the mounting hole 1¾ inches below the upper hole.

NOTE

In some cases it may be necessary to enlarge the rack-mounting holes in the rail to provide adequate clearance for the mounting screws. Then the screws can be turned freely as they are screwed into the bar nut.

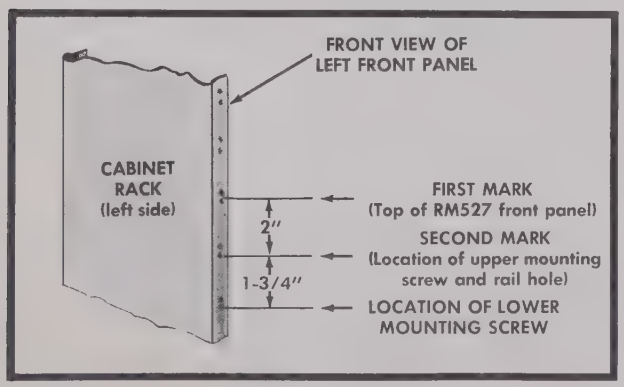

FRONT VIEW OF LEFT FRONT PANEL
CABINET RACK (left side)
FIRST MARK (Top of RM527 front panel)
2"
SECOND MARK (Location of upper mounting screw and rail hole)
1-3/4"
LOCATION OF LOWER MOUNTING SCREW

Fig. 2-4. Determining the Chassis-Trak mounting location.

3. Slip the front lip of the left-hand Chassis-Trak between the rail and the bar nut as shown in Fig. 2-5 (a).

4. Tighten the 10-32 BHS screws so that the Chassis-Trak stationary section is held securely to the rail.

5. Hold the rear support bracket so that it aligns with the rear of the Chassis-Trak stationary section and the rack. Mark two points on the rack for location of the $^{13}/_{64}$-inch holes needed to mount the rear support bracket. If your rack has front and rear rails which are 18 to 18½ inches apart, see Fig. 2-5 (a); if the rack rails are 16⅝ inches to 17⅛ inches apart, see Fig. 2-5 (b). Drill the holes.

6. Fasten the bracket to the rack and to the rear of the stationary section using the flat bar nut, 10-32 BHS screws, 8-32 FHS screws, and nuts. Figs. 2-5, (a) and (b), show the methods used for assembling the bracket in 19-inch and 17-inch racks respectively.

7. Mount the right-hand Chassis-Trak using a procedure similar to that given in the first six steps.

8. Slide the Type RM527 into the Chassis-Trak intermediate sections (see Fig. 2-6) and then slide the instrument to the fully closed position into the rack. Pull the instrument out to the fully extended position and push it back into the rack several times. If the slide mechanism seems to work stiffly, loosen the front rail mounting screws and allow the Chassis-Trak stationary and intermediate sections to align themselves to the inner sections. When the slide mechanism is working smoothly, retighten the mounting screws.

If the instrument is pulled part way out of the rack, pull the instrument out to the fully extended position first before sliding it back into the rack. By doing this, the intermediate sections function properly without sliding to the rear of the rack. If the intermediate sections should slide back too far, extra force is needed to pull the instrument out the next time to make the intermediate sections slide into their proper place.

9. If desired, you may want to keep the Type RM527 fixed in the level position without allowing it to tilt. To do this, use 10-32 BHS screws and nuts to fasten the inner sections securely to the sides of the instrument. Holes are provided for this purpose (see Fig. 2-6).

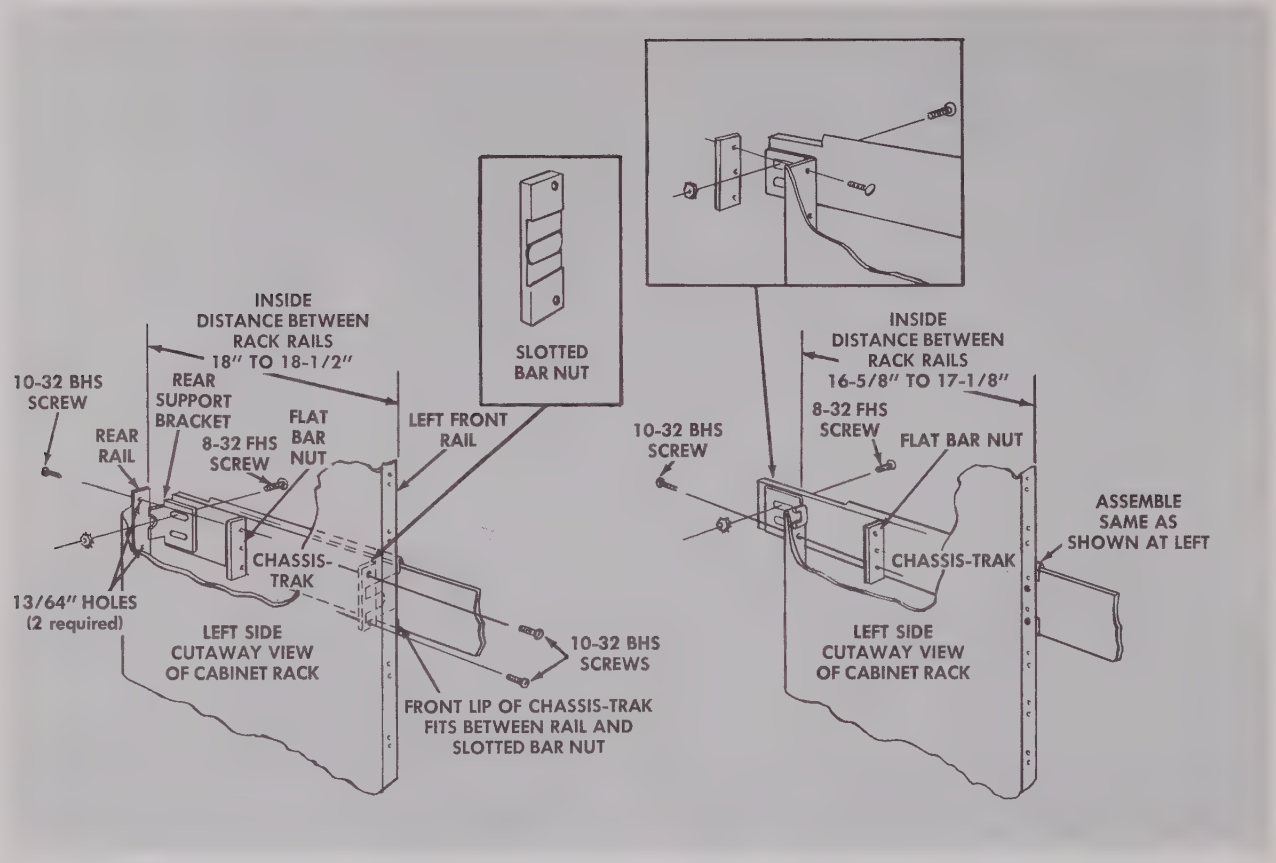


Fig. 2-5. Methods for mounting the Chassis-Traks.

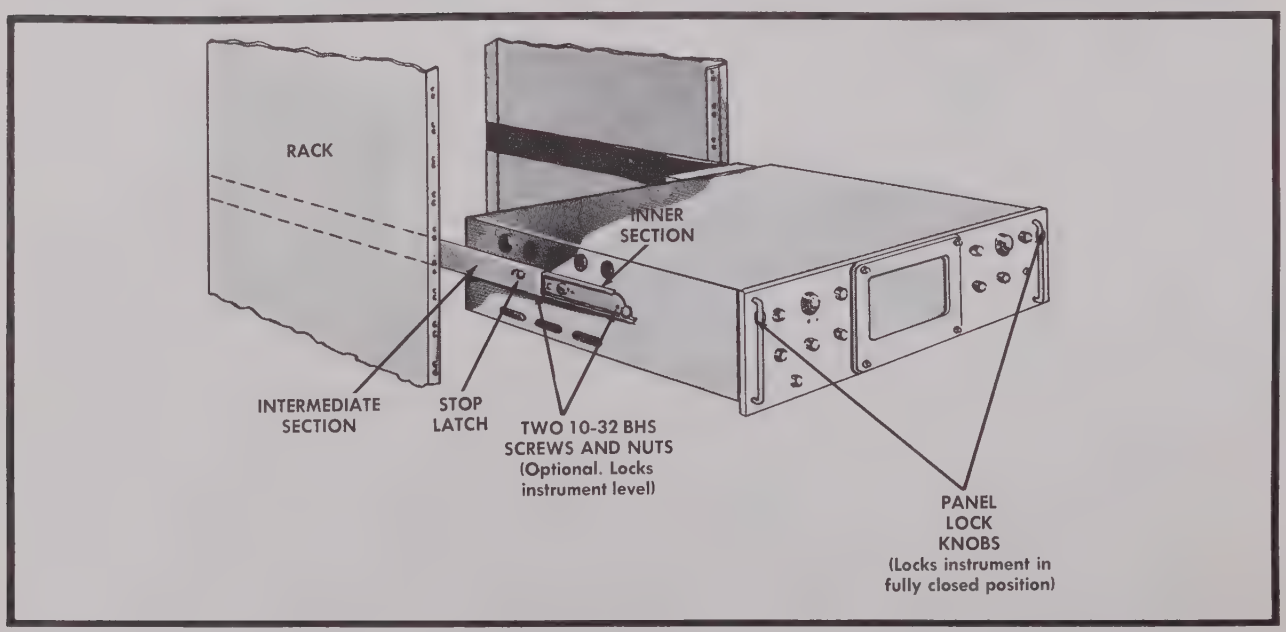
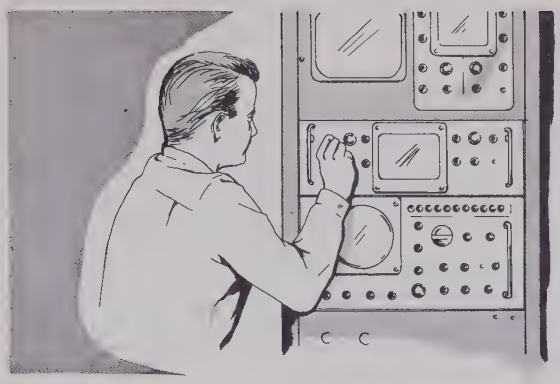


Fig. 2-6. Completed installation showing the Type RM527 in the fully extended position. Depress both stop latches to slide the instrument into the rack or to pull the instrument forward for complete removal from the intermediate sections.



SECTION 3

OPERATING INSTRUCTIONS

FRONT-PANEL CONTROLS

Front-panel views of the Type 527 and RM527 Waveform Monitors are shown in Fig. 3-1. Functions of all front-panel controls are described below in Table 3-1.

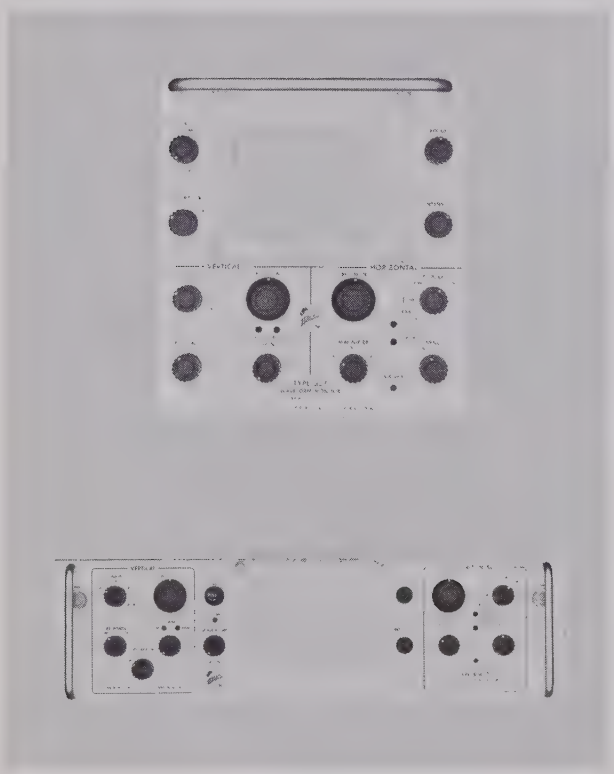


Fig. 3-1. Front-panel views of the Type 527 and RM527.

TABLE 3-1

SCALE ILLUM.

Turns the instrument power on and off, and controls graticule illumination.

FOCUS

Control to adjust the beam for maximum trace sharpness.

INTENSITY

Control to vary the trace brightness.

CALIBRATOR*

Three-position switch to select either a 0.714-volt or 1.0-volt peak-to-peak (±1%) internal calibrator signal, or an external calibration signal.

VERTICAL

INPUT

Four-position switch to select one of four input signals; Calibrator, A, B, or A-B differential.

RESPONSE

Two-position switch to select the amplifier frequency response; IRE (3.58 mc, —20 db) or FLAT (dc to 5 mc, ±1%).

POSITION

Control to position the trace vertically.

GAIN

Continuously variable control with a minimum range of 2.5 to 1 and a LOW-HIGH switch which can reduce the gain 2.5 times in the LOW switch position. The switch is mechanically linked to the GAIN control shaft so that its operation is nearly automatic. When the switch is in the LOW position and the GAIN control is rotated fully clockwise, slight further rotation will actuate the switch. The switch is now in the HIGH position. To return the switch to the LOW position, rotate the GAIN control fully counter-clockwise and actuate the switch. Neon indicator lights above the GAIN control indicate the selected switch setting.

HORIZONTAL

POSITION

A ten-turn control to position the trace horizontally.

* Located in Vertical Block in RM versions.

MAGNIFIER

Three-position switch to select sweep-magnification ratios of X1, X5, or X25 for all except RGB positions of the DISPLAY switch.

DISPLAY

Six-position switch to select RGB field or line, 2 fields or lines of video signal, vertical interval test signal, or 0.125 H/CM sweep rate.

The 2 FIELD or 2 LINE positions of the DISPLAY switch are used for general waveform monitoring. When the DISPLAY switch is set to the 2 FIELD position, the sweep operates at the frame rate, displaying approximately 1½ fields. The FIELD SHIFT button is used in conjunction with this switch position to switch between odd and even fields. When the DISPLAY switch is set to the 2 LINE position, the sweep operates at one-half television line rate, displaying approximately 1½ lines.

In the VIT position, the sweep operates at the field rate and is triggered by the first serrated pulse in the vertical sync pulse train. The sweep rate is such that the sweep will extend past the end of the vertical blanking pulse into the first few lines of the picture. This permits excellent monitoring of details of the vertical interval test signals. With the MAGNIFIER switch set to the X5 position, an entire three- or four-line test signal can be displayed in detail on the screen. When the MAGNIFIER switch is set to the X25 position, any one line will fill the screen.

When the DISPLAY switch is set to the .125H/CM position, horizontal sync timing is measured in terms of H (the time between horizontal sync pulses or the time from the start of one horizontal line to the start of the next line). When the MAGNIFIER switch is placed to the X1 position, one complete horizontal line is displayed in a sweep length of 8 centimeters; see Fig. 3-2 (a). Step 12 in the Calibration section of the manual describes how to calibrate this sweep rate.

For pulse measurements, one centimeter equals 0.125H. For example, in the NTSC signal specifications, 0.125H is the maximum time interval between the leading edge of the horizontal synchronizing pulse and the end of the color burst.

When the MAGNIFIER is placed in the X5 or X25 position, neon lights indicate the time-base rate selected in terms of H for 0.025H/CM or 0.005H/CM pulse measurements.

The .025H/CM position of the MAGNIFIER switch is used, for example, for horizontal pulse measurements, as shown in Fig. 3-2 (b). The .005H/CM position is useful to measure rise and fall times of sync pulses, to count the cycles of color burst [see Fig. 3-2 (c)], and to examine portions of a complete line.

In the RGB LINE and FIELD positions of the DISPLAY switch, the sweep length is reduced to three centimeters, and a 20-cycle staircase CPXR signal of correct amplitude positions the attenuated sweep-trace length to the left during the red line or field display time, to the center during the green line or field display time, and to the right during the blue line or field display time. The instrument does not initiate the camera switching signal. In the RGB FIELD position the sweep operates at the field rate, not the frame rate. In the RGB line position, the sweep operates at the line rate, not one-half of the line rate as in the two-line display.

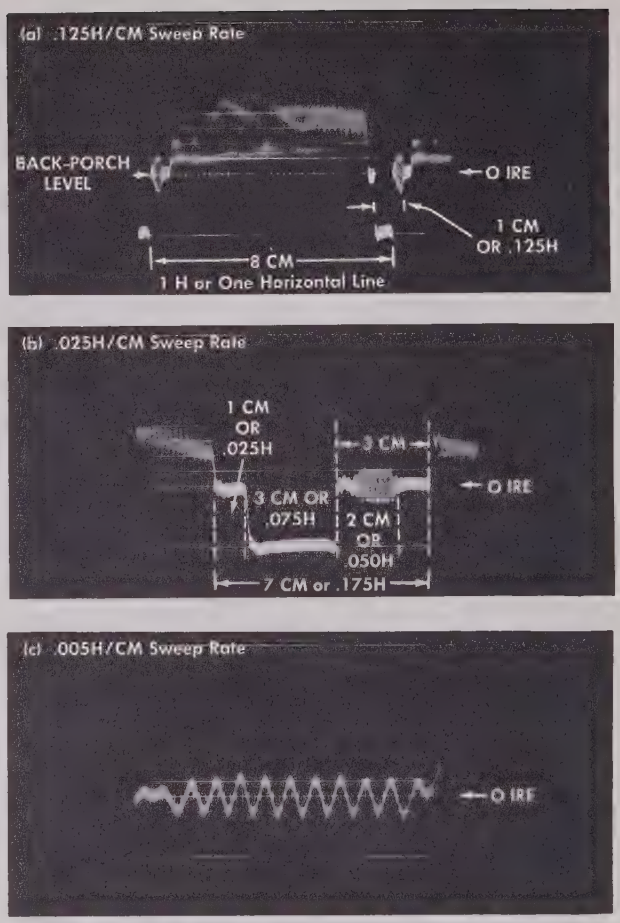


Fig. 3-2. Using the .125H/CM position of the DISPLAY switch, in conjunction with the MAGNIFIER switch, to make horizontal line and sync pulse measurements. (a) MAGNIFIER switch set to the X1 or .125H/CM position, (b) MAGNIFIER switch set to X5 or .025H/CM and (c) MAGNIFIER switch set to X25 or .005H/CM.

FIELD SHIFT

Pushbutton switch for selecting odd and even fields. Use this switch only when the DISPLAY switch is set to the 2 FIELD position.

SYNC.*

Two-position switch to select either internal or external sync.

* Located on rear panel of some instruments.

REAR-PANEL CABLE CONNECTIONS

Two pairs of signal input coax connectors are provided (see Fig. 3-3). These are: VIDEO INPUT A and VIDEO INPUT B. The video inputs are designed for high-impedance loop-through, compensated for 75-ohm systems. If it is necessary to bridge the 75-ohm line, disconnect one of the coax cables at the INPUT selector switch inside the instrument; bridging capacitance is then 47 pf.

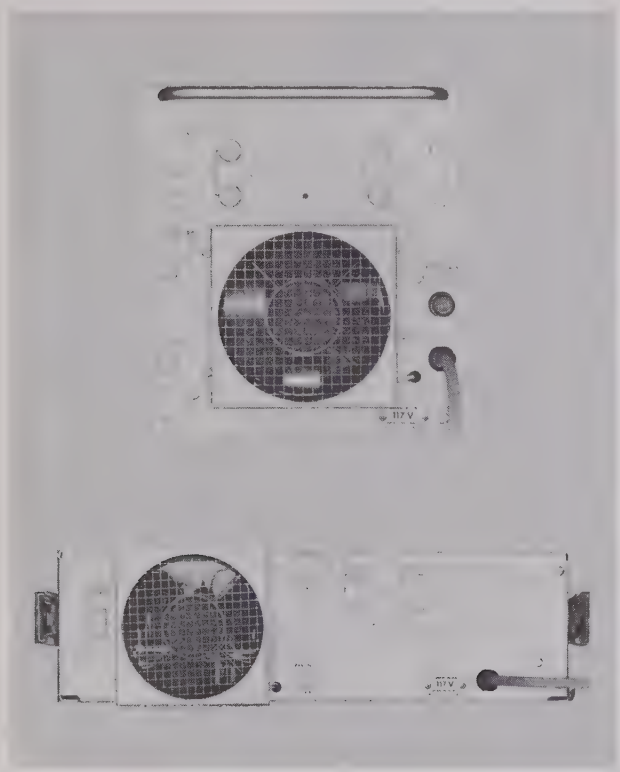


Fig. 3-3. Rear views of the Type 527 and RM527 showing rear-panel connectors.

A third pair of coax connectors, EXT. NEG. SYNC. INPUT, is provided on the rear panel for coupling external sync to the instrument. This input is a high-impedance loop-through, compensated for 75-ohm systems. No modification is required to bridge the line if bridging is necessary; bridging capacitance is 20 pf. To select external sync, place the INT.-EXT. SYNC. switch in the EXT. position.

A fourth pair of coax connectors, EXT. CAL. INPUT, located on the rear panel, is provided to couple external calibration signals to the rear of the instrument. The two connectors are in parallel to couple the signal in and out of the instrument. If a calibration signal is not coupled to these connectors, terminate the connector with a 75-ohm termination to prevent the internal calibrator signal from appearing on the screen when the calibrator switch is set to EXT.

A single connector is provided for coupling an external 20-cycle staircase CPXR signal to the instrument. When this input is not used, the connector may be terminated with a 75-ohm load to prevent stray signal pickup.

When connecting the cables to the Type RM527, use cables which are long enough to allow the instrument to slide out of the rack or console on the Chassis-Trak slides with cables connected.

Ungrounded Input Coax Operation

Under certain installation conditions, if you notice that hum is present with the signal being monitored, you may want to unground the input coax shields to remove the hum. By "floating" the coax shields, differential operation of the instrument may be used to advantage in cancelling a common-mode signal; i.e., the same signal existing on both the inner and outer conductor of the coax.

To unground one or both coax shields in the instrument, refer to Fig. 3-4 to find the location of the grounding jumpers and where to unground them.

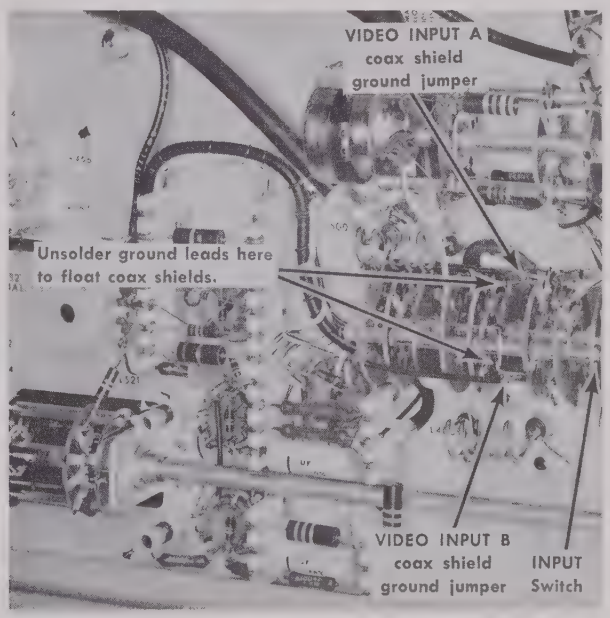


Fig. 3-4. Location of coax ground jumpers on the INPUT switch in the Type 527. Location of jumpers in the Type RM527 is at the same points on the switch.

FIRST-TIME OPERATION

To place the instrument in operation the first time, the following procedure is suggested:

1. Connect the instrument to a source of 50- to 60-cycle, 105- to 125-volt power (or 210- to 250-volt if the power transformer is so wired).

2. Set the front-panel controls as follows, or refer to Fig. 3-1 which shows the controls at the same settings.

SCALE ILLUM.	AC OFF
FOCUS	Centered
INTENSITY	2/3 rotation clockwise
CALIBRATOR*	.714
VERTICAL	
INPUT	CAL.
RESPONSE	IRE or FLAT
POSITION	Midrange
GAIN	LOW and fully counterclockwise
HORIZONTAL	
POSITION	Midrange
MAGNIFIER	X1
DISPLAY	2 LINE
SYNC.**	INT.

3. Turn the SCALE ILLUM. clockwise from the AC OFF position, and let the instrument warm up for a few minutes.

4. Adjust the INTENSITY control for adequate intensity of the square-wave calibrator waveform.

5. Adjust the FOCUS control for the most sharply-defined trace.

To observe other waveforms, connect a video signal to either of the VIDEO INPUT A or B connectors and set the INPUT switch to the appropriate input.

To observe an external calibration waveform, connect the calibration signal to the EXT. CAL. INPUT connector and place the INPUT switch to CAL. and the CALIBRATOR switch to EXT.

Crt Beam Rotator

If the trace does not align with the horizontal graticule lines, the CRT BEAM ROTATOR (R860) needs adjusting.

To adjust this control, first set the front-panel controls the same as for first-time operation (steps 1 through 5). Then set the DISPLAY switch to VIT and adjust the CRT BEAM ROTATOR to align the closely-spaced calibrator pulses with the horizontal graticule lines.

* Located in VERTICAL block in RM versions.

** Located on rear panel of some instruments.

Calibration

The internal calibrator signal is a pulse having a frequency of approximately 30 kc. Two pulse amplitudes are provided: 0.714-volt and 1.0-volt, peak-to-peak, ±1%.

When selecting 0.714-volt calibration pulses the action of the dc-restorer circuit in the vertical amplifier holds the lower half (bottom, as viewed on the screen) of the pulses at a fixed level on the screen, determined by the VERTICAL POSITION control. This is the level at which blanking-pulse back porches are normally clamped.

To calibrate the instrument using 0.714-volt pulses, first use the VERTICAL POSITION control to set the back-porch level of the sync pulses at 0 IRE on the graticule. Then place the INPUT selector switch to CAL., the CALIBRATOR switch to .714, and adjust the GAIN control so that the tops of the calibrator pulses are at 100 IRE units.

The 1.0-volt calibration pulses are primarily useful for calibration adjustments where a 1.4-volt video signal is to be monitored. In this case, 1.0 volt is equal to 100 IRE units. During calibration, the lower half of the 1.0-volt pulses permits the back-porch level to be set at 0 IRE on the graticule.

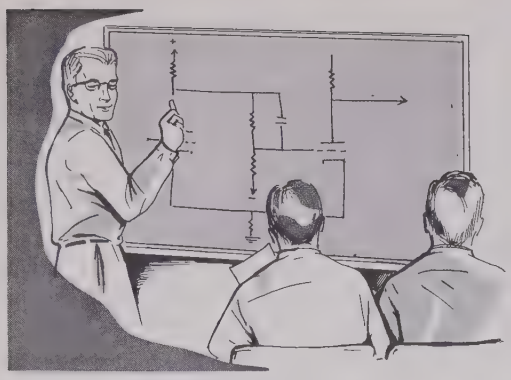
To calibrate the instrument using 1.0-volt calibrator pulses, set the INPUT selector switch to CAL. Set the CALIBRATOR switch to 1.0 and position the lower half of the pulses (to start) at 0 IRE on the graticule. Adjust the GAIN control so the tops of the pulses are at 100 IRE units. Set the INPUT selector switch to A or B (whichever input is used) and the back porch of the blanking pulses will clamp automatically at 0 IRE on the graticule.

When the INPUT selector switch is in the CAL. position, two circuit actions occur.

1. Regardless of whether the SYNC. switch is set to INT. or EXT., the instrument will electronically switch to internal sync.

2. The polarity of the calibrator pulse applied to the Sync Separator Multivibrator stage is automatically inverted while the polarity of the video signal is not inverted. Therefore, the EXT. CAL. INPUT connector should not be used as a third video input.

External calibration pulses must be at line (15 kc) or half-line (7.5 kc) rate for proper dc-restorer action. Clipped, power-line waveforms will not suffice.



SECTION 4

CIRCUIT DESCRIPTION

GENERAL DESCRIPTION

A block diagram of the Type 527 Waveform Monitor is shown in Fig. 4-1. In general, the operation of the monitor is as follows:

An external calibration pulse, an internal calibrator pulse, or a video signal is applied to the Vertical Amplifier. The Vertical Amplifier amplifies the signal and applies it to the vertical deflection plates of the crt. The input signal is also applied to a sync separator circuit in the Sweep

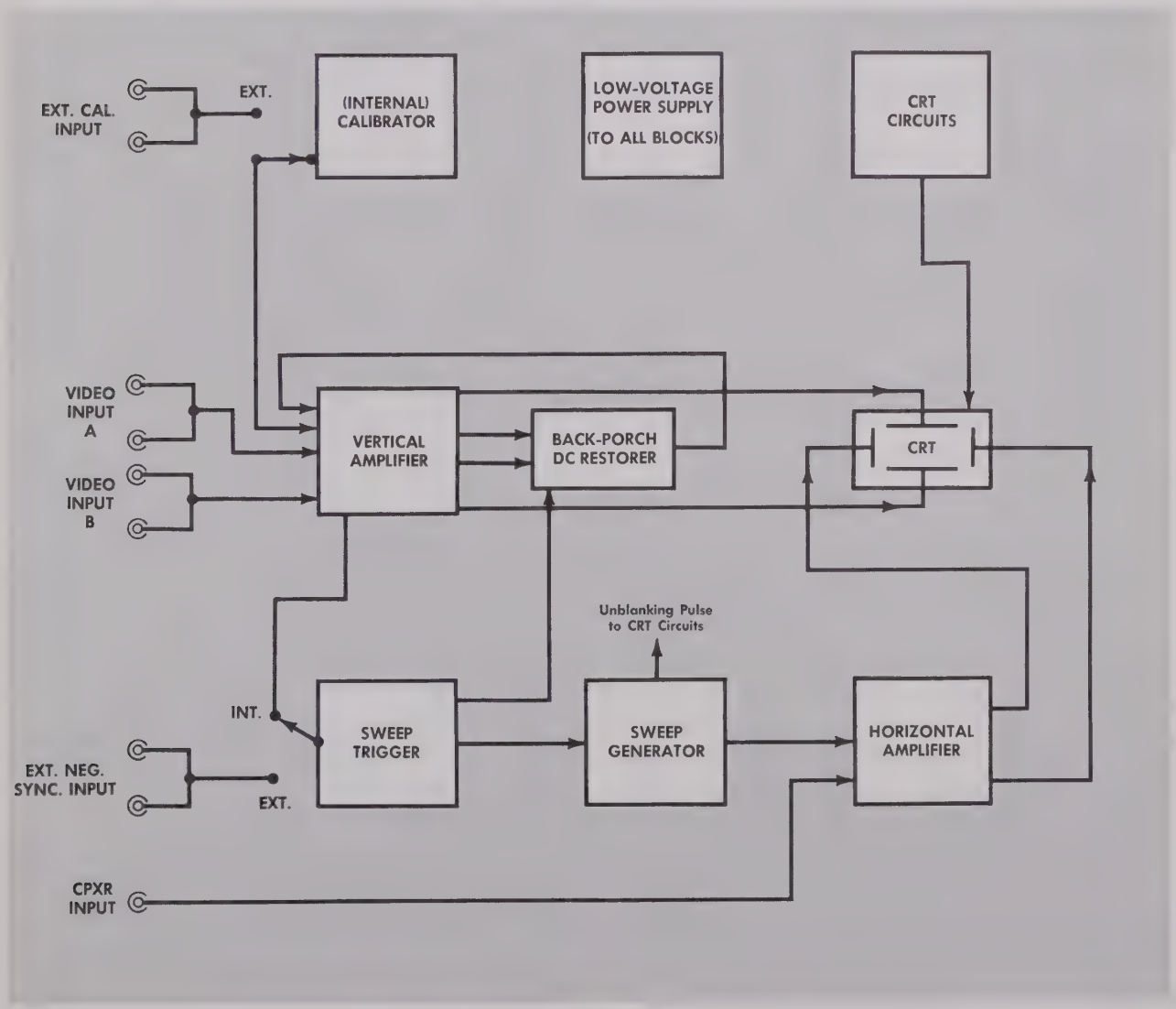


Fig. 4-1. Type 527 simplified block diagram.

Trigger block. A pulse derived from the trailing edge of the separated sync pulses keys the Back Porch DC Restorer. This circuit, by means of feedback to the input amplifier, maintains the back porch of the blanking pulses, or the negative portion of the internal calibration pulses, at a fixed level on the crt. Any drift in the Vertical Amplifier is effectively eliminated by this type of dc restoration. The restorer time constant is made sufficiently long so that low-frequency aberrations in the video signal, i.e., hum and tilt, can be observed.

A pulse derived from the leading edge of the separated sync signal is applied to the Sweep Generator. This pulse triggers the Sweep Generator which generates a linear sweep sawtooth and a retrace blanking pulse.

The sawtooth is applied through the Horizontal Amplifier to the crt to deflect the beam horizontally at a selected, fixed rate. Provision is also made for triggering from an external signal. The external sync signal is applied to the External Negative Sync Input connector through the SYNC. switch when the switch is set to EXT.

The Calibrator provides an amplitude-calibrated pulse for use in calibrating the gain of the Vertical Amplifier. The Low-Voltage Power Supply provides regulated voltages to operate all circuits in the monitor. The CRT Circuits supply the regulated high voltage for the crt.

Virtually all vacuum-tube circuits in the instrument, except for diodes, have "long-tail" cathode circuits. That is, the cathode resistor is returned to a voltage well below the grid level. This configuration sets the cathode current, and therefore stabilizes the gain of the stage. This arrangement also permits the amplifiers to handle large signals.

In the remaining portion of this section, a more detailed description of the operation of each of the Type 527 circuits is presented. Throughout this discussion, you should refer to the block and circuit diagrams contained in the Parts List and Diagrams section of this manual.

VERTICAL AMPLIFIER

The Vertical Amplifier of the Type 527 Waveform Monitor contains separate Input Cathode Followers (V413A and V413B), a two-stage, push-pull Input Amplifier (V424-V524 and V444-V544) and a wide-band, push-pull Output Amplifier (V464-V564) including a cathode-follower Driver stage (V453A-V453B). All amplifier stages operate as differential amplifiers for common-mode signals.

In addition, circuits are provided to dc-stabilize and back-porch clamp the displayed waveform. These circuits are: the Back Porch and Vertical Position Comparator (V484 and V572C), Four-Diode Gate (V572 and V582), DC Restorer Cathode Follower (V582C), and Back Porch Gate Multivibrator (V595). The additional circuitry clamps the back porch of the video blanking pulses so they remain fixed normally at the 0 IRE level on the graticule, depending on the setting of the VERTICAL POSITION control. The VERTICAL POSITION control is used to set the clamp level as desired with respect to the graticule scale.

Except for differential operation, signals from both the A and B VIDEO INPUTS are applied to cathode follower V413A. The grid circuit of the other cathode follower, V413B, is grounded in the A and B positions of the INPUT switch. In the A-B position of the INPUT switch, the circuits are arranged for differential rejection of common-mode signals. In this mode, V413A receives its signal only from the A VIDEO INPUT, and V413B receives its signal from the B VIDEO INPUT.

The maximum overall push-pull gain of the Vertical Amplifier is on the order of 450. This produces the required 140 IRE units of deflection (7 centimeters at approximately 16 volts/cm) at the crt with an input signal of 0.25 volt.

Input Cathode Follower

Signals to be displayed are applied through the A or B position of the INPUT selector switch SW404, and the GAIN switch SW405, to the grid of the Input Cathode Follower V413A. In the LOW gain setting of SW405 neon bulb B406 lights to indicate the selected setting. The signal is attenuated 2.5 times by an RC divider consisting of R406, C406, and R407. When SW405 is set to the HIGH gain setting, neon bulb B405 lights, R406 and C406 are bypassed, and the signal is applied to the grid of V413A without attenuation. C408 and R408 prevent excessive grid current in the event a high positive transient is applied to the input.

Input Cathode Follower V413A is a long-tailed cathode follower; i.e., cathode resistor R412 returns to a voltage well below the grid level. This arrangement permits the handling of large input signals and stabilizes the gain just below unity. The cathode signal is ac-coupled to the grid of Amplifier tube V424.

The operation of V413B is the same as that of V413A, except that it receives its input signal only from the B VIDEO INPUT and only during the A-B mode of operation (differential).

First Differential Amplifier

The first stage of the Input Amplifier V424-V524 amplifies the potential difference between the two grids of the stage. During differential operation, when one grid goes positive and the other goes negative with respect to ground, the output of the stage is proportional to the sum of the two signals. When both grids go positive or both go negative the output is proportional to the difference between the two signals.

Differential operation can be used to advantage, for instance, when monitoring a signal riding on hum. By ungrounding the coax shields at the points shown on the Vertical Amplifier schematic and in Fig. 3-4 of the Operating Instructions, the hum is balanced out by common-mode rejection in the Differential Amplifier stages.

For single-ended operation, the signal is applied to the grid of V424, while the grid of V524 is held stationary. With this configuration, V424-V524 operates as a cathode-coupled paraphase amplifier, having a push-pull output proportional to the signal at the grid of V424.

The plate signals from the first amplifier stage are coupled through "T" inductors L421 and L521, and the RESPONSE switch SW434, to the grids of V444 and V544. The "T" inductors provide the necessary high-frequency compensation.

When SW434 is set to the FLAT position, the signal is coupled through series inductors L434 and L436 which increase the high-frequency response to obtain a flat response out to 5 mc. When SW434 is set to the IRE position, the signal is coupled through larger inductors, L435 and L437. These inductors, in conjunction with capacitors C435 and C437, reduce the bandwidth so the response conforms with the IRE bandwidth standard (23S-1) for pulse measurement.

DC BAL. adjustment R432 sets the dc level of the first-stage through a feed-back loop so that the dc level does not change as the GAIN control R427 is adjusted. The feedback loop is described later when the Back Porch and Vertical Position Comparator circuit is explained. The GAIN control adjusts the gain of the Vertical Amplifier by controlling the amount of cathode degeneration in the first stage. When the control is rotated fully clockwise (zero resistance), the cathodes of V424 and V524 are strapped together and the circuit has maximum gain. When resistance is added by rotating the GAIN control counterclockwise, cathode degeneration is introduced, reducing gain. The special Tektronix-manufactured potentiometer R427 is frequency compensated so that the response does not vary as the GAIN control is adjusted.

Second Differential Amplifier

The signal applied to the second stage of the Input Amplifier, V444-V544, is amplified and coupled through "T" inductors L442 and L542 to the grids of cathode follower V453. The inductors provide additional high-frequency peaking for extended bandwidth.

Diodes D444 and D446 in the cathode circuit operate in conjunction with R445 to improve amplitude linearity in this stage. When large signals are applied, the diodes conduct and shunt R445. This decreases the cathode degeneration for large signals. The increased large-signal gain counteracts compression in the amplifier stages.

Output Amplifier

Cathode Follower V453 presents minimum capacitive loading to the plate circuit of the preceding stage and provides a low-impedance source to drive the capacitance of the Output Amplifier V464-V564.

The signals at the grids of the Output Amplifier are amplified by this stage and coupled through L462 and L562 to the vertical deflection plates of the crt.

Back Porch and Vertical Position Comparator

The Back Porch and Vertical Position Comparator (called the Comparator stage) is composed of V484, V572C, and associated circuitry. This Comparator stage is part of a dc feedback path for the purpose of back-porch clamping the signal at 0 IRE on the graticule, once the signal is positioned at that point with the VERTICAL POSITION control R474. The complete feedback path can be traced as follows: from the grid of V424 to the cathodes of the Output Amplifier, through V484, V572C, V572 (A and B), V582 (A and B), C582C, and then back to the grid of V424.

The Comparator stage operates with an input signal level nearly 40 times greater than the signal level at the grid of V424. With a gain of approximately 40 obtained in the amplifier stages and a gain of 30 in the Comparator, the loop gain is about 1200 as far as the cathode V582C. The total loop gain back to the grid of V424 is reduced from 1200 to 450 by the divider action of R413 and R414. Thus the waveform will drift approximately 0.2% with feedback, compared to a possible 100% without feedback, as the signal varies.

The only other possible drift is that produced by the Comparator and Output Amplifier stages. The resultant drift is very small, however, because the Comparator stage operates at a much higher signal level than the Input Amplifier. Also, excellent correlation between cathode-to-cathode voltage and plate-to-plate voltage in the Output Amplifier is inherent in the design. This circuitry permits the Output Amplifier to be brought within the drift stabilization loop.

Vertical positioning of the trace is accomplished by comparing a voltage obtained from the VERTICAL POSITION control (R474) to a voltage obtained from one of the Output Amplifier cathodes, in the Vertical Position Comparator, V484. Comparator V484 is unable to distinguish between a change in its grid-to-grid voltage caused by a change in cathode-to-cathode voltage in V464 and V564 (a trace shift), and a change in its grid-to-grid voltage produced by an adjustment of R474. In either case, a change in V484A plate voltage causes storage capacitor C582 to charge to a new voltage, which in turn is reflected back to the grid of V424. The positioning voltage is thus transferred to the input of the amplifier via the feedback system. Note that both the positioning voltage and the video signal are applied to the same grid. This prevents common-mode drift between V424 and V524.

Introduction to the DC Restorer

All television waveform monitors have a dc restorer circuit in their vertical amplifier systems to maintain the vertical position of the waveform independent of changes in the average level of the video signal. Sync tip restorers maintain the sync tips at a fixed dc level while back porch restorers operate to hold the blanking pulses at a constant dc level.

Dc restorers may further be classified in terms of their speed. Fast dc restorers can eliminate low-frequency disturbances on the signal such as hum, streaking, and poor low-frequency phase characteristics. Slow dc restorers operate so slowly that such disturbances are not removed but the average back-porch or sync tip level is maintained stable. Waveform monitors require slow dc restorers to show the operator any low-frequency deficiencies in the signal.

The Tektronix Type 527 Waveform Monitor employs a "slow" back-porch dc restorer. This dc restorer maintains blanking pulses at any desired horizontal reference on the graticule. The pulses remain at the desired reference independent of average level changes or variations in amplitude of the signal or drift in the Vertical Amplifier.

Basic Operation of the DC Restorer

The operation of the DC Restorer is best understood by first examining the dc feedback path through the circuit. If the Four-Diode Gate composed of V572 and V582 were replaced with a direct connection from the cathode of V572C to the grid of V582C, a complete dc negative feedback loop would be traced as follows:

From the grid of V424, through the amplifier stages to the grids of V484, to the grid and cathode of V572C, then through the imaginary connection to the grid of V582C, and then from the cathode of V582C back to the grid of V424.

The negative feedback loop operates in the following manner. If the Amplifier tube V424 should drift so that its plate went slightly more positive than that of V524, the control grid of V484A would receive a negative-going dc change. Simultaneously, the control grid of V484B would be driven slightly positive. This change in control grid voltages would cause the plate of V484A to rise. This voltage rise would then be coupled, without polarity inversion, through cathode-follower V572C and the imaginary connection to the grid of V582C, and then from the cathode of V582C through the divider to the grid of V424. The resultant rise at the grid of V424 would then force the plate back to its original level. This action will take place any time that there is a dc level change from side to side in the push-pull Output Amplifier stage of the vertical amplifier. Thus drift, no matter how it is caused, will be cancelled by the action of the dc feedback loop. Such cancellation is highly effective because there is additional amplification of the error signal in V484.

Detailed Operation of the DC Restorer

With the basic feedback path understood we can now consider the action of the Four-Diode Gate, consisting of the two diode sections of V572 and V582. Plate current from pin 6 of the Back Porch Gate Multivibrator V595 flows through the four diodes and back to pin 1 of V595 when the multivibrator is triggered into its astable condition. When current flows through the diodes, a low-impedance path is established from cathode follower V572C to the grid of cathode follower V582C. The potential across storage capacitor C582 can quickly change through this low-impedance path to the voltage at the cathode of V572C. Cathode follower V572C provides the necessary low-impedance point in the circuit for charging C582.

When the Back Porch Gate Multivibrator reverts to its stable state, the Four-Diode Gate is reverse-biased. The diodes prevent C582 from discharging during the stable state or between gating periods of the multivibrator. Thus C582 retains the charge during this period. Note that during the time the multivibrator is in its stable state, the dc level at the grid of V424 is held constant by the charge on C582. Dc continuity or feedback exists through the loop only during the astable condition of the multivibrator (i.e., during gating periods).

Cathode follower V582C couples the voltage from C582 back to the grid of V424 via the dc-level shifting voltage divider, R413 and R414. The divider reduces the feedback voltage but the gain of the loop is high enough for effective feedback. Input coupling capacitor C412, in combination with the voltage divider, forms a low-pass filter having a long time constant of 0.15 second. This corresponds to a 3-db cut-off frequency of one cycle per second. The time constant determines the 3-db point of both the vertical amplifier and the dc restorer.

Storage capacitor C582 should theoretically hold its charge indefinitely during the time the diodes are reverse-biased, but leakage paths in the circuit do exist. The two most significant leakage paths are grid current and heater-to-cathode leakage in V582C. C582 is specially selected to reduce leakage within the capacitor itself.

Dc restoration of the video signal back porch is accomplished by causing the Four-Diode Gate to be driven into conduction during the back porch of all blanking pulses. The back porches are dc restored to a level determined by the setting of the VERTICAL POSITION control R474. In the Type 527, the VERTICAL POSITION control is set so that the fixed level is normally at 0 IRE on the graticule. However, the fixed level may be set anywhere on the graticule, if desired, by means of the VERTICAL POSITION control.

When monitoring a color signal, burst does not affect back-porch clamping because C582 charges to the average level for the duration of the back porch. Also, limited frequency response in the feedback circuits reduces the amplitude of the burst signal to an ineffective level before the signal reaches the Four-Diode Gate.

Back-porch clamping, in turn, does not affect the color signal display because clamping occurs beyond the signal amplifier stages .

Back Porch Gate Multivibrator

Back Porch Gate Multivibrator V595 is a monostable or "one-shot" multivibrator which drives the Four-Diode Gate bridge into conduction for approximately 3 microseconds each time it is triggered. The 3-microsecond gate pulse is a function of the time constant of R596 and C593.

Positive-going sync pulses from the Sync Separator Multivibrator are used to trigger the Back Porch Gate Multivibrator. These sync pulses are delayed for 0.5 microsecond when passing through delay cable L34 (Sweep Trigger diagram). The delay insures that a gate pulse is not obtained until the sync pulses at the cathode of V572C have passed and the back porch is present. In addition, the delay time is sufficient for the back porch to be free of any transients which may follow the trailing edge of sync pulses. Besides providing the delay time, the delay cable serves to feed the sync pulses from one chassis to the other.

After the sync pulses pass through the delay cable, the trailing edge of every sync pulse is differentiated by C34, R590 and R591 for use in triggering the Back Porch Gate Multivibrator.

SWEEP TRIGGER

Sync Selector Switch

The SYNC. switch SW7 selects the source of sync. To describe the operation of the switch and associated cir-

cuitry, the description is divided into two parts: (1) Early production instruments that have the INT.-EXT. SYNC. switch mounted on the rear panel and (2) later production instruments that have the switch mounted on the front panel.

1. Early Production Instruments. When SW7 is set to the INT. position, diode D19 is shorted by the switch. The internal sync from the Internal Sync Amplifier V14 is then coupled to the Sync Amplifier V24. R3, R4 and C7 provide proper loading for the external sync pulse line. When the switch is set to the EXT. position, diode D19 is back biased approximately 13 volts to block all internal sync pulses. Diode D7 is forward-current biased 70 μamps to permit external sync pulses to be coupled to V24.

2. Later Production Instruments. In later production instruments where the SYNC. switch mounts on the front panel, circuit changes permit the signal paths to be remotely switched by means of diodes. The circuit operates as follows:

When SW7 is set to the INT. position, diode D4 turns on. Current flows from ground through R4, D4, and R7 to the +140-volt supply. The potential at the junction of D4 and D7 is approximately +14 volts. The +14 volts back-biases diode D7 to block all external sync pulses. Diode D19 is forward-biased to allow internal sync pulses to pass from the Internal Sync Amplifier V14 to the Sync Amplifier V24. R4 and C4 provide proper loading for the external sync pulse line.

When SW7 is set to the EXT. position, D4 and D19 turn off in all positions of the INPUT switch SW404 except the CAL. position. Simultaneously, D7 turns on and external sync pulses pass through D7 to the Sync Amplifier V24. If the INPUT switch is set to the CAL. position and SW7 remains at EXT., the circuit reverts to the same conditions as described for internal-sync operation, that is, to block external sync pulses.

External sync pulses are attenuated 50% by the network consisting of R1 and C1 working into R7, R19 and R20. The attenuation network lowers the input capacitance and safeguards the diodes from being damaged by large transient pulses.

Internal Sync Amplifiers

Internal sync is picked off from the junction of C412 and R420 in the Vertical Amplifier. Internal sync pulses originate from the following sources (depending upon the setting of the INPUT and CALIBRATOR switches, SW404 and SW880): external calibration pulse, internal calibrator pulse, video signal A or video signal B.

To permit the clamp pulse at the Four-Diode Gate to be related in time with the calibrator pulse, internal sync must be employed whenever a calibrator pulse (either external or internal) is used. This is accomplished by setting the SYNC. switch to the INT. position and setting SW404 and SW880 to the desired positions. The polarity of the internal sync, however, must be inverted when the calibrator is used. This is accomplished by means of two diode switches, D14 and D16. When SW404 is set to the CAL. position, resistor R13 provides forward-biasing current to turn on diode D14. The inverted calibrator pulse at pin 6 of V14 then passes through D14 and following components to the grid of V24. Diode D16 is back biased about 4 volts by R16 and R18.

When using VIDEO INPUTS A or B to display the video waveform, the situation is reversed. Diode D16 is forward-current biased 2 ma and D14 is back biased 4 volts. The in-phase video sync signal at pin 1 of V14 passes through D16 to V24.

Internal Sync Amplifier V14 provides push-pull outputs to diodes D14 and D16 so that either polarity output is available, depending on the dc-biasing of the diodes. When one of the diodes is forward biased by the power supply, the diode behaves as a low-resistance path which is not changed significantly by the small ac signal being coupled through it to the large load resistance.

Sync Amplifier V24 provides phase inversion and sufficient voltage gain for the sync to properly drive the Sync Separator Multivibrator, V35A-V45A.

Sync Separator DC Restorer

Diode V35B restores the sync tips to ground level. The diode is forward biased by current through R31. Forward bias improves the restoration of normal amplitude sync signals.

Sync Separator Multivibrator

The Sync Separator Multivibrator, V35A-V45A, is a Schmitt multivibrator having two stable states. V35A conducts when the leading edge of a sync pulse reaches —1 volt, and V45A cuts off. V35A cuts off when the trailing edge of the sync pulse falls to approximately —2.5 volts and V45A conducts.

Fully separated and regenerated sync pulses are present at the plate of V35A. These pulses are free from noise and hum which may have been present on the original video signal. In addition, the risetime of the regenerated pulses is independent of the risetime of the original sync pulses, due to the regeneration inherent in the multivibrator circuit.

The TRIG. MULTI. BIAS control R39 sets the dc level at which the multivibrator switches. The control is set so the multivibrator switches states at —1 volt and approximately —2.5 volts.

Regenerated sync pulses at the plate of V35A are fed to the grid of V45A and through delay line L34 to the Back Porch Gate Multivibrator, V595.

The leading edges of the regenerated sync pulses at the plate of V45A are used to develop positive-going triggers to trigger the sweep. The sweep is triggered only by vertical sync pulses when delay line L43 is switched into the circuit by the DISPLAY switch, SW160. In alternate positions of the DISPLAY switch, the sweep may be triggered by any type of pulse normally used for synchronization.

Delay line L43 and diode D44 separate the wide serrated vertical sync pulses from the narrow equalizing and horizontal pulses. When V45A conducts, a constant current of approximately 7.2 ma causes a 15-volt drop across R43. When V45A cuts off, the plate voltage rises abruptly 7.5

volts. Energy stored in delay line L43 flows out of the line and maintains the 7.5-volt drop across R43 for 6.7 microseconds (±5%). The energy in the delay line dissipates in 6.7 microseconds and the plate of V45A rises abruptly another 7.5 volts to form a second step. V45A remains cut off until the trailing edge of the serrated sync pulse cuts off V35A and causes V45A to conduct. Diode D44 is biased so that the first or initial voltage jump just brings it to cut off. The second step or delayed jump turns the diode on and the delayed positive-going trigger is fed through C44 to the Sweep-Gating Multivibrator.

Note that a trigger out of diode D44 is delayed 6.7 microseconds from the leading edge of the vertical serrated pulse. If the Sync Separator Multivibrator should revert before this delay expires, no output trigger is obtained from D44. Horizontal sync pulses and equalizing pulses revert the multivibrator before delay line L43 discharges and thus no triggers are produced until the serrated vertical sync pulses arrive.

NOTE

Delay line L43 has a delay time of 6.7 microseconds, within a tolerance of 5%. This delay is sufficient for American NTSC color and monochrome systems, the 819-line French system, and for the CCIR system in Europe. For the British 405-line standard a longer delay line is needed. To obtain a longer line of correct length, add a second identical-length L43 line.

When delay line L43 is switched out of the circuit in the alternate positions (LINE, 2 LINE, and .125H/CM) of the DISPLAY switch, all sync pulses trigger the multivibrator to produce 15-volt positive pulses at the plate of V45A. Since diode D44 is biased so that pulse amplitudes above 7.5 volts cause the diode to conduct, the trigger pulses are the same 7.5-volt amplitude and nearly the same risetime as those produced when the delay line is in the circuit.

SWEEP GENERATOR

The sweep generator in the instrument is a Miller run-down circuit. This circuitry generates a negative-going, linear sweep sawtooth.

In the quiescent condition, V45B of the Sweep Gating Multivibrator is cut off and V145A is conducting; screen current from V145A passes through Disconnect Diode V152A and R160. The drop across R160 sets the voltage at the grid of the Miller Integrator, V161A. The quiescent level at the cathode of V161B is +180 volts.

If the grid of V161A tends to go negative, the plate of V161A rises. The cathode of V161B rises, and a portion of the rise voltage is applied to the grid of V152C. Since V152C is a cathode-follower, the cathode voltage rises. The rise at the cathode of V152C pulls up the cathode of V152A, increasing its impedance. Less screen current from V145A then flows through V152A and R160, and this action arrests the tendency for the grid of V161A to go negative. A complete dc feedback loop is provided by this circuitry to maintain the dc levels during the quiescent condition, between sweeps.

When a positive-going trigger pulse from C44 causes V45B to conduct, the Sweep Gating Multivibrator switches and V145A cuts off. V152B then clamps the screen circuit of V145A near ground, which cuts off the Disconnect Diode V152A. Deprived of screen current from V145A, the grid of the Miller tube V161A starts positive and its plate starts to drop. However, negative feedback from the cathode of V161B through the Timing Capacitor (one of the C160 capacitors) prevents the grid of the Miller tube from changing. The Timing Capacitor then charges at a constant rate through R160 which causes the cathode of V161B to run down at a linear rate from an initial +180-volt level to about +40 volts. Thus, a 140-volt sawtooth is generated.

A portion of the negative sawtooth voltage is fed back to the grid of V45B which cuts off V45B when the cathode of V161B runs down to about 40 volts. The Sweep Gating Multivibrator then switches states and V145A conducts. Screen current from V145A quickly turns on V152A and the sweep returns to its quiescent level of +180 volts. When this occurs, V152C conducts and diode V152B unclamps from ground potential. V152C then prevents any further change in the voltage at the cathode of V161B.

The crt unblanking pulse is developed at the plate of V145A and coupled to the grid of the Unblanking Cathode Follower V145B. V145B provides a fast-rise positive unblanking pulse at its cathode. The unblanking pulse is applied to an unblanking deflector electrode in the crt to drive the electrode to +60 volts.

The unblanking circuitry in the instrument acts like a dc-coupled switch. During the quiescent condition, the voltage at the cathode of V145B is approximately —60 volts, which turns the beam off. When the sweep starts, the plate of V145A is driven positive and V145B drives the crt deflector to +60 volts, which turns on the electron beam in the crt.

Proper action of the Sweep Generator depends upon correct biasing of the Sweep Gating Multivibrator. Correct biasing voltage is set by adjusting the SWP. GATING MULTI. BIAS control R176 so that V45B is biased just below cut off with the sweep at the quiescent level. Correct bias voltage insures that a trigger will start the sweep but not permit the sweep to free run.

When the DISPLAY switch is set to the 2 FIELD position and the FIELD SHIFT switch SW178 is closed momentarily, capacitor C178 quickly discharges through the parallel path of R176, and R175 in series with R173, to the —140-volt bus, and then through R179. As C178 discharges, a 125-volt negative-going pulse is produced at the junction of R175 and R176. This pulse reverts the Sweep Gating Multivibrator before the sweep sawtooth reaches full amplitude, thus permitting the multivibrator to be triggered by the next field sync pulse.

HORIZONTAL AMPLIFIER

The sweep sawtooth from the cathode of V161B is attenuated by R320, C320 and C321, working against R321, R330, R332, C331, and C332. Variable capacitor C320 is adjusted for linear sweep start with the MAGNIFIER switch SW335 set to the X1 position. C331 and C332 set the time constant for the X1 MAGNIFIER switch position.

In the X5 position of the DISPLAY switch, the sweep sawtooth is attenuated by R320, C320 and C321 working against R321, R330, R334, C333, and C334. C333 and C334 sets the time constant for this position.

Similarly, for the X25 position of the DISPLAY switch, R320, C320 and C321 work against R321, R330 and C336 to attenuate the sweep sawtooth. C336 sets the time constant for this position.

The time constants of both the X5 and X25 positions of the MAGNIFIER switch are adjusted to match the X1 time constant. The HORIZONTAL POSITION control R323 varies the dc voltage at the grid of V343B to horizontally position the trace on the crt.

Neon bulbs B338 and B339 are indicator lights for the .025H/CM and .005H/CM sweep rates, respectively. When the DISPLAY switch is set to the .125H/CM position and the MAGNIFIER switch set to X5, neon bulb B338 lights to indicate that the sweep rate is .025H/CM. When the MAGNIFIER switch is set to the X25 position, neon bulb B339 indicates that the sweep rate is .005H/CM.

The SWP./MAG. REGIS. control R355 adjusts the current through V343B so that the junction of R353 and R354 is at approximately ground potential. The control is adjusted so that the MAGNIFIER switch expands the portion of the unmagnified sweep that appears at the center of the graticule. Control R355 has the same adjustment range regardless of MAGNIFIER switch settings while the HORIZONTAL POSITION control has maximum effect when the MAGNIFIER is set to X25.

To accurately adjust R355 with the MAGNIFIER switch set to X25, the HORIZONTAL POSITION control is first used to position the start of the sweep to the center of the graticule. Then the MAGNIFIER switch is set to X1 and R355 is adjusted to position the start of the sweep to the center of the graticule. If R355 is adjusted correctly, the start of the trace will not shift when the MAGNIFIER switch is set to the X25 position and then returned to the X1 position.

The CPXR INPUT is provided for use with color process amplifiers which provide a three-level, 20-cps pulse, synchronized with a three-input video switcher. The video switcher permits successive red, green, and blue line- or field-rate displays to be observed side by side on the screen. The width control provided in the color process amplifier must be adjusted to obtain a proper non-overlapping RGB display on the instrument. Normally, the MAGNIFIER switch is set to the X1 position when observing this display. Since the CPXR input is dc-coupled to the Horizontal Amplifier, good low-frequency response is obtained. When the CPXR input is not used, the input should be terminated with a 75-ohm load to prevent unwanted signal pickup from being amplified by the Horizontal Amplifier.

The sawtooth is converted to a push-pull signal in the Phase Inverter V374, and amplified in the Output Amplifier V384. The amplified sweep sawtooth is direct-coupled to the horizontal deflection plates in the crt. HORIZ. GAIN control R375 is adjusted for the desired sweep length, normally 10 centimeters. Adjustment of the HORIZ. GAIN control, however, affects the timing. Therefore, this control should always be adjusted before other horizontal timing adjustments are made.

LOW-VOLTAGE POWER SUPPLY

Plate and filament power for the tubes and transistor in the Type 527 Waveform Monitor is furnished by a single power transformer, T601. The primary has two equal windings which are connected in parallel for 117-volt operation, or in series for 234-volt operation.

Three main power supplies, with capacitor-input filters, furnish regulated voltages of —140, +140, and +280 volts. The +280-volt supply also has an unregulated output of about +440 volts for the crt high-voltage supply. It is unnecessary to regulate this voltage as the high-voltage supply has its own regulating circuit.

The —140-volt supply is a full-wave, bridge-type rectifier circuit. Reference voltage for the —140-volt supply is established by a gas-diode VR tube, V619. This tube, which has a constant voltage drop, establishes a fixed potential of about —55 volts at one grid of the Difference Amplifier, V626. The grid potential for the other half of the Difference Amplifier is obtained from a divider consisting of R631, R632 and R636. The setting of the —140 V adjustment, R636, determines the percentage of the total output that appears at the grid of V626B and thus determines the total voltage across the divider. When this adjustment is properly set, the output of the —140-volt supply will be exactly —140 volts.

Should the loading on the —140-volt supply tend to change, an error voltage will exist between the two grids of the Difference Amplifier. The error signal is amplified by V626, whose plate is dc-coupled to the grid of the Series Regulator, V627. The error voltage appearing at the grid of V627 will change the bias and, hence, the impedance of V627. This will allow more or less current, as required, to flow through the load to force the output voltage to its original level. Resistor R627 shunts the Series Regulator to increase the available current from the supply. C631 improves the ac gain of the feedback loop, and thus increases the response of the circuit to sudden changes in output voltage. C614B is capable of furnishing high pulse currents, when demanded by the load. This capacitor sets the time constant of the regulator circuit to prevent the circuit from oscillating.

The —140-volt supply serves as a reference for both the +140-volt and the +280-volt supplies. In the +140-volt supply, the divider R661 and R662 establishes a voltage of essentially zero at the grid of the Amplifier, V654. The exact voltage at the grid of V654 will be equal to the bias required by the tube. If the loading should tend to change the output voltage, an error voltage will appear at the grid of the amplifier. The error voltage will be amplified and will appear at the grid of the Series Regulator, V657. The cathode of V657 will follow the grid, and thus the output voltage will be returned to its established value of +140 volts. C661 improves the response of the Series Regulator circuit to sudden changes in output voltage, and R657 increases the available output current. C612B has the same function as described for C614B. Two diode rectifiers, D612, A and B, provide full-wave rectification for the +140-volt supply.

The +280-volt supply functions in the same manner as the +140-volt supply except that four diodes, D610, A and B, and D612, A and B, provide full-wave bridge-type rectification. Note that the +280-volt Series Regulator is

referenced to both the —140- and +140-volt supplies. If the +280-volt supply is in regulation, both of the other supplies must also be in regulation. As mentioned previously, the +280-volt supply also provides an unregulated output of about 440 volts for the crt high-voltage supply.

For instruments S/N 151 and above, the CRT BEAM ROTATOR circuit shown on the Power Supply schematic diagram provides a high-current source for L860. CRT BEAM ROTATOR control R860 sets the current through L860 so the trace can be aligned with the graticule lines. For an additional description of beam rotator circuits which includes circuits below S/N 151, refer to the CRT Circuit description that follows.

CRT CIRCUIT

A 30-kc Hartley oscillator circuit furnishes energy for the Calibrator and the crt. The main components of the oscillator are V800 and the primary of T801 tuned by C808.

The rectifier circuit is the half-wave type, with a capacitor-input filter. V822 normally supplies —3800 volts for the cathode, approximately —3850 volts for the grid, and —3000 volts for the focusing anode. The actual voltages at the grid and focusing anode depend upon the setting of the INTENSITY (R848) and the FOCUS (R845) controls.

In order to maintain a constant deflection sensitivity in the crt, and thereby maintain the calibration of the instrument, it is necessary that the accelerating potential remain constant. This is accomplished by comparing a "sample" of the high voltage to the regulated —140-volt supply. The error signal, obtained from the junction of R841-R842, is amplified by V814B and applied to V814A. The output of V814A varies the screen voltage of the oscillator tube, thereby controlling the amplitude of its output.

Neon bulbs B847 and B848 maintain a constant voltage across divider resistors R847 and R848 to hold the cathode of the crt at a constant potential as the INTENSITY control is varied. When the control setting is changed, the crt beam current changes. The current change is coupled through the neons instead of through the two resistors.

Resistor R851, connected from the crt cathode to the filament, raises the potential of the filament so that it is the same as the cathode. The resistor isolates the crt filament winding in the power transformer from the crt cathode.

Two unblanking deflector electrodes, connected to pins 6 and 7 of the crt, act as a dc-coupled switch to turn the beam on and off. The electrode connected to pin 6 is biased at +60 volts; the electrode connected to pin 7 is the switching electrode. During the Sweep Generator quiescent level, the unblanking pulse from the cathode (pin 1) of V145B biases the switching electrode at approximately —60 volts, turning the beam off. When the sweep starts, the unblanking pulse rapidly drives the switching electrode to approximately +60 volts and the beam turns on. The beam remains on for the duration of the pulse, which is the same as the sweep sawtooth. At the end of the sweep the unblanking pulse drops to —60 volts, and the beam turns off.

A beam rotator coil L860 located inside the crt shield permits the trace to be rotated about an axis through the center of the screen by varing the current through the coil. CRT BEAM ROTATOR control R860 varies the current through the coil and is adjusted to align the trace parallel to the graticule lines.

Two Beam Rotator circuits are shown on the CRT Circuit and Calibrator schematic diagram. Either circuit is used in instruments below S/N 151. For the circuit used in instruments S/N 151 and up, refer to the Low Voltage Power Supply description in this section of the manual.

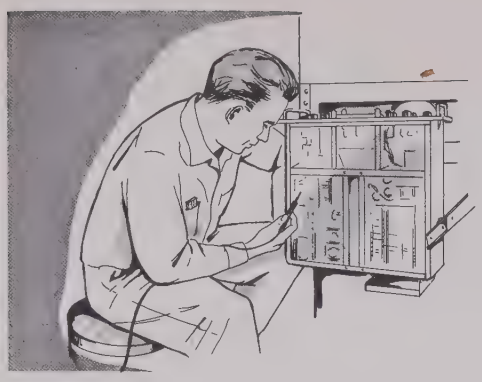
To align the trace with the graticule in some early production instruments below S/N 151, the Low Current Beam Rotator circuit is used. Other early production instruments required more current to rotate the crt beam. In these instances, the High Current Beam Rotator circuit is used. In instruments using the high-current circuit, leads to L860 must be reversed to reverse the rotation of the trace.

CALIBRATOR

The Calibrator provides a 0.714- and a 1.0-volt pulse for use in calibrating the gain of the Vertical Amplifier to equal 100 IRE units on the screen. The two amplitudes are obtained by tapping at different points on a voltage divider.

The calibrator pulse is produced in the following manner: A sine wave with an amplitude of about 4.5 volts and a frequency of approximately 30 kc, obtained from the secondary of T801, drives transistor Q874 from cutoff to saturation. When Q874 is in saturation, the collector voltage drops to zero. When Q874 cuts off, zener diode D882 holds the collector at —6 volts, preventing the collector from increasing to about —45 volts (the voltage at the junction of R875 and R886, with Q874 and D882 disconnected). These two actions result in a low-impedance square wave where the top is formed by Q874 driven heavily into saturation and the bottom by D882 driven into its zener region.

The CAL. AMPL. control, R886, provides a means for adjusting the drop across resistors R884, R882 and R880 by controlling the current through them. CALIBRATOR switch SW880 selects either the 0.714-volt or 1-volt points on the divider, or an external calibration signal.



SECTION 5

MAINTENANCE

PREVENTIVE MAINTENANCE

Reoiling Of Muffin Fan

If the fan is sluggish in coming to speed, will not start without assistance, or takes more than 90 volts to start, reoiling may be effective in restoring it to use.

This can be done as follows:

1. If the Muffin has a paper label on the spider face, cut away a circular portion of the label about ½" diameter, which will expose the rubber dust cap covering the bearing and shaft end. This may be pried out with the end of a knife or needle. Hold the fan with the shaft vertical and the prop down. Fill the space around the end of the shaft with SAE 10 or 3-in-1 oil, or use a good grade of light instrument oil such as Aeroshell Fluid No. 12 or Esso P.38. Run the unit for as long as possible without replacing the cap, in the same position. Oil should be absorbed after several hours. Fan speed should be at least 3050 rpm. Replace cap and reinstall the unit.
2. After a long period of running or after running in excessively high ambient temperatures, a black, gummy substance may be formed from the oil. This can be cleaned out from the area around the end of the shaft with a lint-free cloth or absorbent paper.
3. If the amount of this black substance is too great to permit free running even after reoiling, the unit will have to be disassembled and cleaned. This is done by removing the two steel grip rings in the shallow groove at the end of the shaft.

   After cleaning, reassemble the unit and reoil as in step 1.

Cleaning the Graticule

To clean the graticule and the face of the crt, first remove the four graticule nuts. Then remove the graticule cover and the graticule. Clean the graticule and the face of the crt with a soft, lint-free cloth dampened with denatured alcohol.

Cleaning the Interior

Dust should be removed occasionally to prevent instrument failures due to overheating caused by a heavy accumulation of dust. Use a small, dry paint brush and a vacuum cleaner to dislodge and remove the dust. Persistent dirt on vacuum tubes can be removed with a damp cloth.

As an alternative method, compressed air may be used to keep the interior of the instrument clean. A very high velocity air stream should be avoided, however, to prevent damage to some of the components.

Visual Inspection

Every few months, the Type 527 should be visually inspected for possible circuit defects. These defects may include such things as loose or broken connections, damaged connectors, improperly seated tubes, scorched wires or resistors, missing tube shields, and broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential to determine the cause of overheating before replacing heat-damaged parts in order to prevent further damage.

Calibration

The Type 527 Waveform Monitor is a stable instrument which should provide many hours of trouble-free operation. However, to insure the reliability of measurements we suggest that you calibrate the instrument after each 500 hours of operation (or every six months if used intermittently). A complete step-by-step procedure for calibrating the instrument is presented in Section 6 of this manual.

REMOVAL AND REPLACEMENT OF PARTS

General Information

Most parts in the instrument can be replaced without detailed instructions. Other parts, however, can best be removed if a definite procedure is followed. Instructions for the removal of some of these parts are contained in the following paragraphs. Because of the nature of the instru-

ment, replacement of certain parts will require that you recalibrate portions of the instrument. Refer to the Calibration portion of this manual for the applicable calibration steps.

CRT Replacement

To remove the cathode-ray tube, first disconnect the socket and the four clip leads connected to the neck of the tube. Do not unsolder the leads going to the Beam Rotator coil. Remove the graticule cover, graticule, and green filter. Loosen the clamp at the base of the crt. Remove the tube by pushing forward on the base and then pulling the tube straight out through the front panel (see Fig. 5-1).

When the new crt is in place and the clamp is tightened, connect the leads to the neck pins by following the color code information on the tube shield. Remount the green filter, graticule, and graticule cover.

After the crt is replaced and the instrument is operating, you should check the horizontal gain, sharpness of the trace, and alignment of the trace with the graticule markings. The procedures for making these checks are described in steps 7, 8, and 19 in the Calibration section of this manual. Since these steps have to be performed out of sequence, use the information which directly precedes step 1 for presetting the front-panel controls. Connect a video signal to the instrument as directed in the first part of step 5, and then proceed with step 7.

In step 8 of the Calibration procedure, once the ASTIG. control is set, no further adjustment will normally be necessary for the life of the crt. When you are ready to perform step 19, set the INPUT selector switch to A-B and proceed with the step. If your instrument is below S/N 151 and if the CRT BEAM ROTATOR control does not have enough range to align the trace with the graticule lines, refer to the Circuit Description section and to the circuit diagrams for more information about the circuits used.

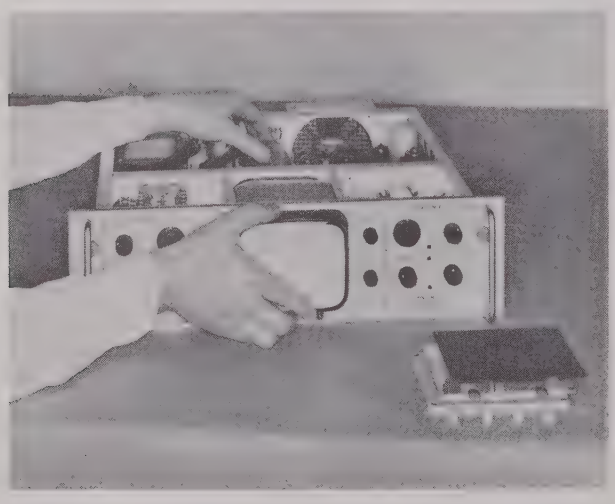


Fig. 5-1. Removing the crt from the Type RM527. The same general procedure is used to remove the crt from the standard Type 527.

Replacement of Switches

Methods for removal of switches are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the instrument. If one wafer is defective, the entire switch should be replaced. Switches may be ordered from Tektronix either unwired or with the parts wired in place.

When soldering leads to a new switch, do not let solder flow around and beyond the rivet on the switch terminal. Excessive solder may destroy the spring tension of the contact.

Tube Replacement

Care should be taken both in preventive and corrective maintenance that tubes are not replaced unless they are actually causing trouble. During routine maintenance, it will often be necessary to remove tubes from their sockets. It is important that these tubes be returned to their same sockets unless they are actually defective. Unnecessary replacement or switching of tubes may require recalibration of the instrument. If tubes do require replacement, it is recommended that they be replaced by previously checked high-quality tubes.

Tube testers are not recommended for use in checking tubes. A tester may indicate a tube to be bad when that tube is operating quite satisfactorily in a circuit, or it may fail to indicate tube defects which affect the performance of the circuits. The only criterion for the usability of a tube is whether or not the tube works properly in the circuit.

Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond can be broken by repeated use of ordinary tin-lead solder, or by the application of too much heat. However, occasional use of ordinary solder will not break the bond if too much heat is not applied.

It is advisable to have a stock of solder containing about 3% silver if you frequently perform work on Tektronix instruments. This type of solder is used frequently in printed circuitry, and should be readily available. It may also be purchased directly from Tektronix in one-pound rolls (order by part number 251-514).

Because of the shape of the terminals on the ceramic strips, it is advisable to use a wedge-shaped tip on your soldering iron when installing or removing parts from the strips. A wedge-shaped tip allows you to apply heat directly to the solder in the terminals, and reduces the amount of heat required. It is important to use as little heat as possible. To prevent chipping of the strip, use care when applying the soldering tip to the terminals.

When soldering delicate components, such as diodes and transistors, use the following technique: (1) Use long-nose pliers to hold the lead securely between the component

and the point where heat is applied, allowing the pliers to serve as a heat sink. (2) Use a hot iron for a short time. (3) Handle the component leads carefully to prevent lead breakage.

Ceramic Terminal Strips

Damaged terminal strips are most easily removed by first unsoldering all connections, then using a plastic or hard rubber mallet to knock the yokes out of the chassis. This can be done by using the mallet to hit the ends of the yokes protruding through the chassis. The strip with the two yokes can then be removed as a unit. The spacers will probably come out with the yokes. If not, the spacers can be pulled out separately.

Another way of removing the terminal strip is to use diagonal cutters to cut off one side of the yokes holding the strip. This method permits the strip to be removed from a difficult area where the mallet cannot be used effectively. The spacers and the remainder of the yokes can be pulled out separately after the removal of the strip. Since a replacement strip is supplied with yokes already attached, the old yokes need not be salvaged. However, the old spacers can be used at least twice before new ones are required. When ordering spacers, specify mounting height ($\frac{5}{32}$", $\frac{1}{4}$", or $\frac{3}{8}$") from chassis to strip; when ordering ceramic strips, specify part number, number of notches, and height of strip ($\frac{7}{16}$" or $\frac{3}{4}$").

When the damaged strip and yoke assembly has been removed, place the spacers into the holes in the chassis. Then set the ends of the yoke pins into the spacers. Press or tap lightly directly above the yokes to drive the yoke pins down through the spacers. Be certain that the yoke pins are driven completely through the spacers. Using a pair of diagonal cutters, cut off the portion of the yoke pin protruding through the spacers. Fig. 5-2 illustrates the way that the parts fit together.

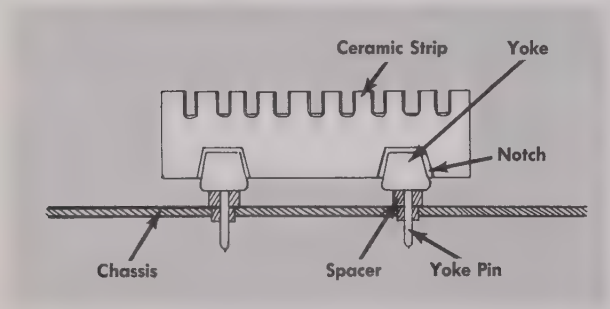


Fig. 5-2. Installation of ceramic terminal strips.

TROUBLESHOOTING

General Troubleshooting Information

This portion of the instruction manual will aid you in troubleshooting the instrument in the event that trouble develops. During troubleshooting work, the information contained in this section should be correlated with information in other sections of the manual.

When trouble occurs in the instrument, an attempt should be made to isolate the trouble by quick operational and visual checks. You should first recheck the settings of all controls to see that they are set properly. Then operate the front-panel controls to see what effect, if any, they have on the trouble. The normal or abnormal operation of each control will allow you to firmly establish the trouble symptoms in your mind. The location of a trouble which occurs only in certain positions of a control can usually be determined immediately from the symptoms.

After the trouble symptoms are clearly established, look first for the obvious. Check to see that the pilot light (in the Type RM527 only) is on (in the Type 527 check to see if the graticule lights are on); feel for any irregularities in the operation of the controls; listen for any unusual sound; see that the tube heaters are on, and visually check the entire instrument. The type of trouble will often indicate the checks to make.

In general, a troubleshooting procedure can be thought of as consisting of two parts: (1) circuit isolation and (2) circuit troubleshooting. In many cases, the general procedure outlined will enable you to accomplish the first part of the procedure. You have then only to find the exact cause of the trouble in the isolated circuit. If the above procedure does not enable you to isolate the defective circuit, then additional checks will be required. After the defective circuit has been determined, detailed checks within the circuit will allow you to determine the exact cause of the trouble.

Separate circuit diagrams for each main circuit will be found at the rear of this manual. In addition, a block diagram provides an overall picture of instrument operation. The reference designation of each electronic component, and important voltages and waveforms, are found on the circuit diagrams. The following is a list of the reference designations associated with each circuit.

Numbers less than 100	Sweep Trigger
100 numbers	Sweep Generator
300 numbers	Horizontal Amplifier
400 and 500 numbers	Vertical Amplifier
600 numbers	Power Supply
800 numbers	Crt Circuit and Calibrator

Switch wafers shown on the circuit diagrams are coded to indicate the physical positions of the wafers on a switch. The number portion of the code refers to the wafer number on the switch assembly. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

All wiring used in the Type 527 is coded to facilitate circuit tracing. In addition, primary power, filament, and regulated power supply leads are distinguished by specific color codes. All power-supply output leads follow the standard EIA code. For example, the —140-volt bus is coded brown-yellow-brown, on black (black indicates a negative voltage). The +280-volt bus is coded red-gray-brown on white (white indicates a positive voltage). The widest stripe identifies the first color of the code.

In the troubleshooting tables that follow, reference is made in several places to the use of an oscilloscope to check the waveform at some point in the circuit. Because of the fast-rise and short-time duration of some of the waveforms, it will be necessary to use a wide-band oscilloscope for these checks. A 5-mc instrument is the minimum. If possible, a 10-mc (or better) oscilloscope should be used.

Tables 5-1 and 5-2 can be used to troubleshoot the instrument. Table 5-1 lists possible symptoms or apparent troubles that could be encountered. This table can be used to isolate certain troubles to a main circuit and, in some cases, to a particular stage or component within a main circuit. Table 5-2 can then be used to locate the trouble in the isolated main circuit or in a particular part of the main circuit. References in Table 5-1 direct you to the appropriate step or steps in Table 5-2.

It is clearly not possible to include all possible troubles in a troubleshooting table, and therefore only those troubles most likely to occur are included. Troubles not found in the tables must be located using the general method of first isolating the defective stage and then determining the cause of the trouble within the stage.

Table 5-2 can also be used independently. The steps in Table 5-2 are arranged so that they can be used to perform a quick check on the operation of each main circuit. The table is subdivided into separate sections for the circuits contained in the instrument, so that if you isolate a trouble to a main circuit, you can proceed directly to the appropriate section of Table 5-2 without first using Table 5-1.

Although the Type 527 is a stable instrument, it is possible for circuits to get out of calibration, thereby producing an apparent trouble. Before proceeding with any detailed trouble analysis check to see if the trouble can be corrected by means of some adjustment. If there is any doubt, recalibrate the entire suspected circuit using the information in Section 6.

Some "misleading troubles" could occur if trouble develops in one of the power supplies. The circuit configuration is such that an incorrect power-supply voltage might affect one circuit more than others. Consequently, power supply trouble should be considered as a possibility for virtually any type of circuit failure. If there is any doubt as to whether a power supply may be causing the trouble, the power supply voltages and ripple should be checked before proceeding with detailed troubleshooting procedure. If the output and ripple voltages of the regulated power supplies are correct, the power supplies can be assumed to be operating correctly.

When trouble has been isolated to a definite circuit, perform a complete visual check of that circuit. If a visual check does not indicate the cause of trouble, check the tubes, preferably by substitution. Be sure to return all good tubes to their original sockets.

Rectifier and semiconductor defects usually take the form of the component either opening or shorting. A check for either of these conditions can usually be made using an ohmmeter. Checks should be made with the ohmmeter leads first one way and then the other so that the effects of the polarity reversal can be observed. If there is doubt about whether the component is good or not, substitute another for it. Then check the associated circuitry.

NOTE

Avoid overheating a semiconductor when soldering. Use the technique described under Soldering Precautions in this section. Observe polarity when replacing a diode in the circuit.

Zener diode D882 and transistor Q874 defects can be checked by making waveform or voltage measurements during operation of the instrument. If the waveform at the collector of Q874 is 20 volts peak-to-peak in amplitude instead of 6 volts, or if the voltage reading is about 9.8 volts, D882 is open and must be replaced. If the waveform or voltage measurement is extremely low, either the diode or the transistor could be shorted, and both components should be checked.

TABLE 5-1

TROUBLE	PROBABLE CAUSE	CHECKS TO MAKE	IF NORMAL	IF ABNORMAL
1. Scale illumination, pilot light (RM527 only) and tube heaters do not light.	Line power not applied. Fuse F601. Power switch SW601. Power Transformer T601.	See that oscilloscope is properly connected to the power source. Then check for correct line voltage between terminals 1 and 4 of T601.	T601 is probably defective.	F601 or SW601 is probably defective.
2. No video waveform display or trace on the screen with INPUT switch set to either A or B, INTENSITY control set for normal brightness, and POSITION controls centered.	Loss of video signals to A and B connectors. INT-EXT. SYNC. switch set to EXT. when no external sync is used. Causes of trouble can be external to the Type 527, or can be internal. Proceed to next columns and follow instructions.	1. Check the signal source for 0.25-volt or more signal. Set the EXT.-INT. SYNC switch to INT.	Proceed to check 2 in this table.	Apply proper amplitude video signal to VIDEO INPUT A connector.
		2. Set INPUT switch to CAL., CALIBRATOR switch to .714, DISPLAY switch to .125H/CM and MAGNIFIER to X1. The calibrator waveform should appear.	Troubleshoot from the VIDEO connectors to INPUT switch SW 404.	Proceed to check 3.
		3. Check for correct regulated power-supply output voltages of all supplies including the —3800-volt supply.	Proceed to check 4.	If one or more of the power-supply voltages are abnormal, check supply. For —140-volt supply refer to step 1; for +140-volt supply refer to step 10; for +280-volt supply, refer to step 17; for —3800-volt supply, refer to step 18. Table 5-2 contains all steps listed above.
		4. Short vertical deflection plates together with jumper lead. Trace should appear.	Remove jumper and proceed to Vertical Amplifier Introduction which precedes step 28, Table 5-2.	Remove jumper and proceed to check 5.
		5. Apply correct amplitude sync pulses to EXT. NEG. SYNC. INPUT connector. Set INPUT switch to A with signal applied to VIDEO INPUT A. Video waveform should appear.	Troubleshoot Internal Sync Amplifier stage, V14. Also, refer to step 37, Table 5-2.	Proceed to check 6.
		6. Check waveforms at pin 8, V161 and pin 1, V145 in the Sweep Generator.	Proceed to check 7.	If waveform at pin 8, V161 is normal but waveform at pin 1, V145 is abnormal, proceed to step 45, Table 5-2. If neither waveform appears, proceed to step 40, Table 5-2.

TABLE 5-1 (continued)

TROUBLE	PROBABLE CAUSE	CHECKS TO MAKE	IF NORMAL	IF ABNORMAL
		7. Up ot this point the only main circuit that remains to be checked is the Horizontal Amplifier circuit. To see if Horizontal Amplifier is at fault, remove V384. A vertical trace should appear that varies in amplitude according to signal changes.	Proceed to step 47, Table 5-2.	Proceed to step 20, Table 5-2.
3. Trace not focused properly.	FOCUS and ASTIG. controls not adjusted correctly. CRT circuit.	Adjust FOCUS and ASTIG. controls as described in Calibration procedure, Section 6. Trace should focus properly.	Trace focuses properly and instrument operates normally.	Proceed to step 18, Table 5-2.
4. Trace does not align with horizontal graticule lines.	CRT BEAM ROTATOR control not set correctly. CRT circuit in instruments below S/N 151; Power Supply circuit in instruments S/N 151 and up.	Adjust CRT BEAM ROTATOR control as described in Operating Instructions. Trace should align with graticule marking.	Trace aligns properly.	Trouble in Beam Rotator circuit. Check continuity of L860 and voltages applied to circuit.
5. No calibrator pulse display.	T801 secondary open. Transistor Q874 defective. Zener diode D882 shorted. Trouble in associated calibrator circuitry.	Check waveform at base of Q874. Normal waveform should be displayed on test oscilloscope.	Troubleshoot for possible circuit discontinuity between CALIBRATOR switch, SW-880, and the INPUT switch, SW404. Use oscilloscope to trace waveform to source of trouble.	If normal waveform is not displayed, proceed to step 27, Table 5-2. If waveform is abnormal, proceed to step 26, Table 5-2.
6. Excessive calibrator pulse amplitude display Video waveform amplitude normal.	D882 open.	Check waveform at collector of Q874. If D882 is open, waveform amplitude will be 20 volts peak-to-peak, instead of normal 6-volts.	Waveform is abnormal, proceed to If Abnormal column.	Replace D882.
7. Insufficient vertical deflection, both A and B channels.	V424, V524, V444, V544, V453, V464, V564 and associated circuitry in the Vertical Amplifier.	Check tubes by substitution first.	Check components which can affect the gain but not the dc balance of the circuits, such as the GAIN switch SW405, plate-dropping resistors, screen resistors.	Replace the defective tubes as required. Adjust DC BAL. control; see Calibration procedure.
8. Poor common-mode rejection with the INPUT switch set to A-B and GAIN switch set to HIGH.	V413 and associated circuitry in the Vertical Amplifier.	Check V413.	Check all input circuitry from input connectors to grids of the following stage, V424-V524.	Replace the defective tube.
9. Poor common-mode rejection with INPUT switch set to LOW.	C406 and C506 incorrectly adjusted.	Adjust C406 and C506; see steps 17 and 18 in Calibration procedure.	Trouble is corrected.	C406 or C506 defective.

TABLE 5-1 (continued)

TROUBLE	PROBABLE CAUSE	CHECKS TO MAKE	IF NORMAL	IF ABNORMAL
10. Low-requency waveform distortion (characterized by "tilt" on vertical sync pulse tip).	Troubles in the Vertical Amplifier such as faulty tubes and grid current flow. C412 or C417 defective.	Check tubes in Vertical Amplifier.	Check the push-pull stages for grid current. Locate and correct cause of trouble. Check C412 or C417 for possible cause.	Replace the defective tube(s) as required. Adjust DC BAL. control; see Calibration procedure.
11. High-frequency waveform distortion. (Characterized by excessive "overshoot" or "undershoot" at the leading edge of horizontal sync pulses, insufficient bandpass characteristics.) GAIN switch set to HIGH.	Troubles in the Vertical Amplifier such as: faulty tubes, improper adjustment of the peaking coils, bypass capacitors open or shorted.	Check tubes in Vertical Amplifier.	Check for shorted or partially shorted peaking coils.	Replace the defective tube(s) as required. Adjust DC BAL. control; see Calibration procedure.
12. Mid-frequency waveform distortion only with the GAIN switch set to LOW.	C406 set incorrectly.	Check adjustment of C406. See steps 17 and 18 in Calibration procedure.	Mid-frequency distortion corrected.	C406 defective. Replace.
13. FIELD SHIFT button does not cause fields to shift.	Defective switch SW178, R178, R179 or C178.	Check switch SW178 for continuity when switch is depressed.	Check R178, R179, and C178.	Replace the defective switch SW178.
14. Nonlinear sweep.	Nonlinear sweep sawtooth caused by the Sweep Generator or Sweep Amplifier circuits.	Observe waveform at pin 8, V161 (Sweep Generator circuit).	Proceed to step 46, Table 5-2.	Proceed to step 47, Table 5-2.
15. Free-running sweep.	SWP. GATING MULTI. BIAS adjustment (R176) set incorrectly.	Adjust R176 for correct setting; see Calibration procedure.	Sweep should trigger properly.	If sweep free runs and cannot be triggered, proceed to step 44, Table 5-2.
16. No horizontal deflection. Screen glows when INTENSITY control is set fully clockwise. Screenglow area changes as the VERTICAL POSITION control is rotated.	Change in dc level, starting at grid of V374A. Change in dc levels because of troubles in V374 and V384 Horizontal Amplifier stages.	Check V343, V374 and V384.	Troubleshoot associated circuitry.	Replace the defective tube(s) as required.
17. No horizontal deflection (spot or vertical trace at center of crt and cannot be positioned with the HORIZONTAL POSITION control).	V374 or V384 filament open.	Check V374 and V384.	Trouble is corrected.	Proceed to step 48, Table 5-2.
18. Insufficient horizontal deflection (short trace).	Sweep sawtooth produced by Sweep Generator stage low in amplitude, or trouble in Horizontal Amplifier circuit. HORIZ. GAIN control may need adjusting.	Substitute tubes in Horizontal Amplifier (V343, V374, V384). Check adjustment of HORIZ. GAIN control.	Trouble is corrected.	Check waveform amplitude at pin 8, V161. Sweep may revert too soon. If so, check R170, R172, and R173. If amplitude is still low, check V161. If amplitude is normal, proceed to step 47, Table 5-2.

TABLE 5-2

STEP	IF NORMAL	IF ABNORMAL
—140-Volt Power Supply		
1. Check for —140 volts at output of —140-volt supply. Use an accurate (1%) voltmeter.	Proceed to step 2.	If voltage is not zero, proceed to step 5. If voltage is zero, proceed to step 7.
2. Set INPUT selector switch to A and disconnect video signal from VIDEO INPUT A. Check full-wave ripple at output of —140-volt supply. Should be approximately 5 mv or less, but no more than 20 mv (at nominal line volts).	Proceed to step 3.	Check V626 and V627. If still abnormal, proceed to step 3.
3. Check full-wave ripple at + side of C614A.	Proceed to step 4.	Check C614A. If C614A is good, proceed to step 4.
4. Connect instrument to variable autotransformer. Check that —140-volt supply regulates when line is varied between 105 and 125 volts (if wired for 117-volt operation) or 210 and 250 volts (if wired for 234-volt operation).	Power Supply is operating correctly.	
5. Using the —140V control, attempt to set output of power supply to —140 volts. It should be possible to obtain the correct voltage.	Trouble has been corrected. Check regulation (step 4).	Check that output varies as —140V control is adjusted. If it does, check R631 and R632. For further checks proceed to step 6.
6. Disconnect R627 and the load external to the —140-volt supply. Check regulation of —140-volt supply again. Check R627 at this time.	—140-volt supply operates normally. Check for trouble in load circuits. V627 possibly weak; check this tube.	If supply does not regulate, measure voltage across C614A at nominal line. If abnormal, check rectifiers D614, A, B, C, and D. Otherwise, proceed to step 7. Replace R627 if defective.
7. Measure rms voltage between terminals 12 and 13, T601.	T601 is operating properly.	T601 defective (shorted turns in winding connected to terminals 12 and 13, or a turn shorted to another winding).
8. Measure voltage at the plate of V626B.	If normal, check V627 and associated circuits. After finding trouble, proceed to step 9.	If abnormal, check V619, V626, and V627. Check associated circuits. After finding trouble proceed to step 9.
9. Reconnect load and R627 to —140-volt supply. Adjust —140V control for output of —140 volts.	Check ripple and regulation by repeating steps 3 and 4.	
+140-Volt Power Supply		
10. Check for +140 (±4.2) volts at the output of the +140-volt supply.	Proceed to step 11.	If voltage is incorrect by a small amount (4% or 5%) but seems to regulate, check R661 and R662. Proceed to step 11 and check ripple voltage. If voltage is low, check V657. If voltage is zero, proceed to step 15.
11. Place INPUT switch to A and disconnect video signal from VIDEO INPUT A. Check ripple at output of the +140-volt supply. Should be approximately 5 mv or less, but no more than 20 mv (at nominal line volts).	Proceed to step 12.	Check V654 and V657. If still abnormal, proceed to step 12.

TABLE 5-2 (continued)

STEP	IF NORMAL	IF ABNORMAL
12. Check ripple at the + side of C612A.	Proceed to step 13.	Check C612A.
13. Connect instrument to a variable autotransformer. Check that supply regulates when line is varied between 105 and 125 volts (if wired for 117-volt operation).	Power supply operating normally.	Check rectifiers D612, A and B. Proceed to step 14.
14. Measure plate voltage of V654. If output of supply is high, V654 should be conducting heavily to decrease the grid voltage of V657. If output is low, V654 should nearly cut off to raise the grid voltage of V657. Measure resistance to ground at +140-volt test point, with negative ohmmeter lead connected to ground. Reading should be approximately 11.5 k.	Voltage and resistance readings are normal.	If resistance at test point is high or low, disconnect R657 and the load external to the supply. Check regulation of the +140-volt supply. If it regulates, trouble is in load circuits. If it does not regulate, proceed to step 15.
15. Measure voltage across C612A.	Check V657. Check R657 at this time while it is disconnected.	Proceed to step 16.
16. Check voltages between terminals 14 and 15, and 15 and 16, of T601. After performing this step, reconnect the load and R657. Repeat steps 10 and 11.	Check rectifiers D612, A and B.	T601 defective.
+280-Volt Power Supply		
17. Use the same general troubleshooting procedure described for the +140-volt supply. (Typical resistance-to-ground measurement of this supply is approximately 17.5 k with negative ohmmeter lead connected to ground.)		
CRT Circuit		
18. Check for —3800 volts at the junction of B847 and R847.	Proceed to step 19.	If voltage is —140 volts or less, proceed to step 24. If voltage is near —3800 volts, proceed to step 23. If the voltage is between —4100 volts and —4900 volts, replace V814.
19. Vary the setting of the INTENSITY control, and vary line voltage between 105 and 125 volts (117-volt operation) while checking voltage at junction of B847 and R847. The supply should regulate between these limits.	If supply regulates, operation is normal. Proceed to step 20.	Proceed to step 23 (If Abnormal column).
20. To check crt, see if neon bulbs B847 and B848 increase in brightness as INTENSITY control is rotated clockwise.	If neon bulbs change in brightness, the crt is operating normally.	If no trace appears on crt, use an oscilloscope to check for unblanking pulse at pin 1, V145 (or remove crt socket and check for unblanking pulse at pin 7 of the socket). If neon bulbs do not change in brightness, check crt voltages before replacing crt. Proceed to step 21.
21. Check crt filament circuit.	Proceed to step 22.	Crt filament may be open; filament leads from terminals 17 and 18 of T601 may be open; T601 winding to terminals 17 and 18 may be open. Replace defective wire or component.

TABLE 5-2 (continued)

STEP	IF NORMAL	IF ABNORMAL
22. Check FOCUS control. Check voltages at pins 4, 6 and 11 of the crt.	Supply voltages to crt are normal. Trouble is probably a defective crt.	Locate cause of incorrect voltage(s) and correct the trouble (possibly crt).
23. If voltage at —3800V test point is near correct value, adjust —3800V (R841) control for proper voltage.	Perform step 19 to check high-voltage regulation.	If voltage cannot be brought to the proper value, or will not regulate, the regulator circuit (V814) is probably faulty. Check V814. Proceed to step 24.
24. Check for heater glow in V822.	Check for open plate lead from V822 to voltage divider (R848 to R840).	Proceed to step 25.
25. To check oscillator operation, measure voltage at grid of V800. Or, hold a neon bulb near filament leads of V822. Neon bulb should glow.	Check V822 and T801 secondary winding.	Check V800 and associated circuit.
Calibrator		
26. Check calibrator waveform at base of Q874 (INPUT switch set to CAL.).	Calibrator is operating normally.	If the waveform does not have a saturated appearance (flattened lower half of cycle) check Q874. If waveform is not obtained, proceed to step 27.
27. Check continuity of T801 secondary winding after disconnecting coax at T801 end.	Secondary winding of T801 has continuity. Check coax for continuity or short.	If winding is open, replace T801.
Vertical Amplifier		
The Vertical Amplfier contains the signal amplifier stages and the dc restorer stages (Back Porch and Vertical Position Comparator, Four-Diode Gate, Back Porch Gate Multivibrator, and DC Restorer Cathode Follower). Most are high impedance circuits, and it is important to use a high-impedance (10 meg or higher) voltmeter, such as a VTVM, for measurements. Even so, errors will be introduced at some points. Also, it is important to use a calibrated oscilloscope, having a bandpass of at least 5 mc, with a low-capacitance probe when signal-tracing. Servicing procedures in this case must include the servicing of feedback loops, or delays in diagnosing the trouble may result. In such a loop system, if one voltage is wrong, all voltages will probably be wrong. Therefore, the best approach is to break the feedback loop and observe the results. The following procedures lists the logical steps for troubleshooting, when you are unable to obtain either the video waveform or the calibrator pulse.		
28. To determine whether the trouble is in the amplifier stages or in the dc restorer feedback loop, short grid (pin 1) of V424 to grid (pin 1) of V524.	If trace appears, signal stages from the grids of V424-V524 to the output (crt vertical deflection plates) are normal. The trouble is in the grid circuits of V424-V524, or in the dc restorer feedback loop. Proceed to step 32.	If no trace appears, the trouble is in the amplifier stages. Proceed to step 29.
29. To check amplifier stages, short pin 2 of V464 to pin 2 of V564, with a jumper lead.	Trace should appear. Circuits are normal between this point and the crt.	If trace does not appear, check V464 and V564. Check voltages and components.
30. Remove jumper connecting pin 2 of V464 and pin 2 of V564.	Trace should remain on crt.	If trace does not remain on crt, proceed to step 31.
31. Short between corresponding points on opposite sides of the circuit, starting at the grids of V453 and working back toward the grids of V424-V524.	When trace appears, the stages following the jumper (looking toward the crt) are balanced or normal.	When trace does not appear, the stage immediately following the jumper (looking toward the crt) is causing the imbalance. Check for a defective tube, component, or open connections (for example, open inductors).

TABLE 5-2 (continued)

STEP	IF NORMAL	IF ABNORMAL
32. Disconnect jumper connecting grids of V424 and V524.	If trace appears, the Vertical Amplifier, including the dc restorer, is operating normally.	If trace disappears, check grid circuits of V424-V524 (for example, C412 or C417 may be leaky). Then proceed to step 33 to check dc restorer stages.
33. To check dc restorer feedback loop, short cathode (pin 1) of V464 to cathode (pin 1) of V564. See if VERTICAL POSITION control causes cathode (pin 9) of V572C to move about 30 volts (72 volts to 102 volts).	Check the Back Porch Gate Multivibrator, V595, for probable trouble. Check for possible trouble between V595 and Sync Separator Multivibrator, V35A-V45A. For more details, proceed to step 34 (and possibly step 36).	Check V484 and V572C circuitry.
34. If the cathode of V572C swings 30 volts, check voltage swing at the cathode of DC Restorer V582C. The swing should be about 20 volts (82 volts to 102 volts).	Four-Diode Gate, Back Porch Gate Multivibrator and Sweep Trigger circuits operate normally. Proceed to step 35.	Check the Four-Diode Gate circuits V572A, V572B, V582A and V582B.
35. With cathodes of V464-V564 still strapped together, measure plate voltage of V424 with VTVM. Plate swing should be about 6 volts (about 3 volts on either side of —10.5 volts) as VERTICAL POSITION control is adjusted.	DC restorer circuits are normal. Remove jumper.	Check V424 stage for proper voltages. Check faulty components.
36. Check for proper trigger pulse at the grid (pin 7) of V595A.	Check V595 stage voltages and components. Check diode D596.	Check delay cable (L43) by trying the 2 LINE positions of the DISPLAY switch (SW160). If pulse appears, replace L43. If pulse does not appear, proceed to step 37 (Sweep Trigger circuit).

If the previous steps do not help you find the trouble, you may want to disconnect the dc restorer circuit. Then the feedback loop and the amplifier stages of the Vertical Amplifier may be checked independently. You can then troubleshoot in the normal manner, using an oscilloscope and/or a VTVM. To disable the dc restorer action, use either of the following methods:

METHOD 1 — Remove V582. Connect a 470 k, ½-watt resistor from pin 9 of the V582 socket to the wiper arm of the VERTICAL POSITION control R474 (junction of wiper arm lead and R471 on the terminal strip). Connect a 33 k, ½-watt resistor from pin 9 of the V582 socket to +140 volts (see Fig. 5-3).

These alterations permit the VERTICAL POSITION control to feed a dc-bias voltage to the input of V424. The trace can now be positioned vertically on the screen and normal operation, except for dc-restoration, can be obtained.

Note that with the Vertical Amplifier operating and with proper functioning of the Vertical Position Comparator V484, the plate (pin 6) of V484 swings from 72 volts to 95 volts as the VERTICAL POSITION control is rotated (with the GAIN control set to HIGH and rotated fully counterclockwise). Cathode follower V572C should follow, but considering its bias, the cathode of V572C will run about 8 volts higher than the plate of V484. (The trace movement will lag slightly in response as the VERTICAL position control is rotated.)

With this setup, the dc restorer feedback loop is open, and the Back Porch Gate Multivibrator waveforms are affected slightly both in duration and amplitude as the VERTICAL POSITION control is rotated. However, this will not interfere with troubleshooting the amplifier stages.

METHOD 2 — This method disables the Back Porch Gate Multivibrator in such a manner that the Four-Diode Gate is always closed, causing continuous feedback. To produce this condition, the multivibrator must be biased into its normally astable state. To do this, connect a 330 k, ½-watt resistor from +140 volts to the junction of R590, R591 and R592.

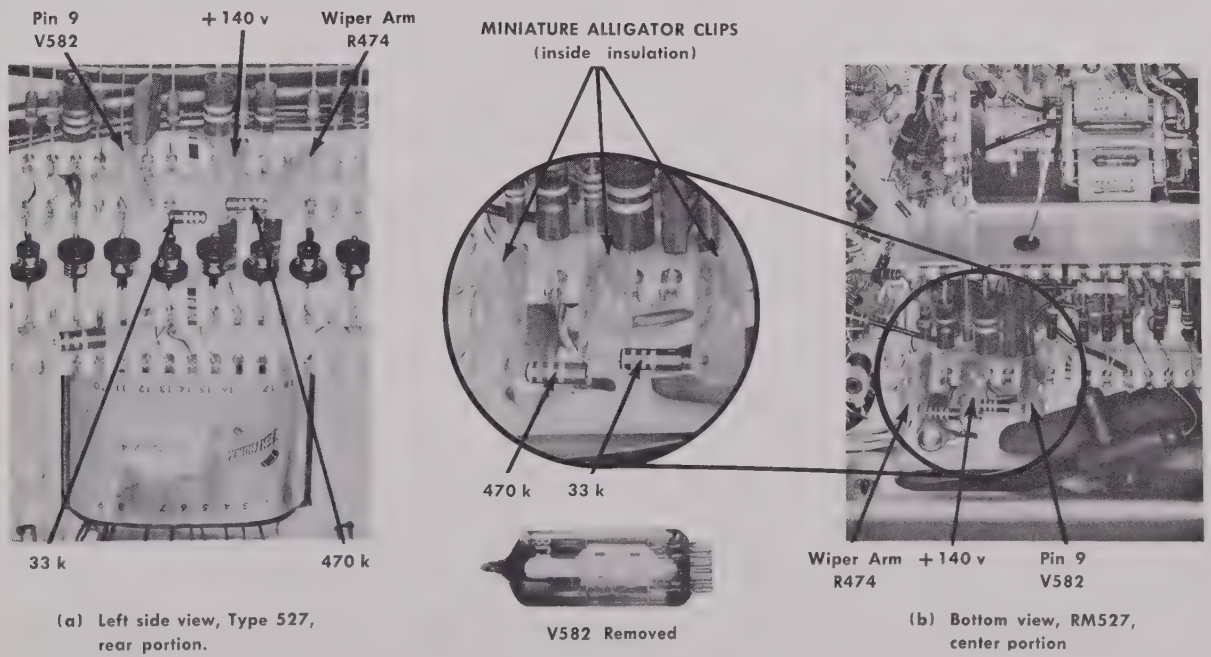
Trigger the instrument externally, but do not apply any signal to the Vertical Amplifier. The dc feedback loop will function, and there should be normal positioning range with no trace drift. With the GAIN control set to HIGH and rotated fully counterclockwise, the plate (pin 6) of V484 should swing from 79 to 85 volts as the VERTICAL POSITION control is rotated.

TABLE 5-2 (continued)

STEP	IF NORMAL	IF ABNORMAL
Sweep Trigger		
37. Apply a composite video signal to VIDEO INPUT A connector. Set INPUT switch to A and INT.-EXT. SYNC. switch to INT. Use an oscilloscope to check waveform at pin 7, V35.	Proceed to step 38.	Check V14 and V24. Check voltages at tube pins. Check diodes D14, D16 and D19. (In later circuits check diode D4 also.)
38. Check waveforms at pin 6, V35 and pin 1, V45 in the Type 527, or pin 1, V35 and pin 6, V45 in the Type RM527.	Sweep Trigger circuit operates normally when triggered with internal sync signals. To check circuit using external sync pulses, proceed to step 39.	Check V35 and V45. Check for an open circuit, such as L34. Diode D44 may be open or shorted. Check TRIG. MULTI. BIAS adjustment according to information in the Calibration procedure.
39. Apply external sync to EXT. NEG. SYNC. INPUT connector and set INT.-EXT. SYNC. switch to EXT. Check waveform at pin 1, V24.	External sync input circuit operates normally.	Check C3 and adjustment of C1. Check R1, R3, R4, R7, D4, D7 and D19 and INT.-EXT. SYNC. switch SW7.
Sweep Generator The Sweep Generator is another example of a feedback circuit. When it fails, the problem is to find where the break in feedback occurred. The general procedure is to determine whether the Sweep Generator locks at the start or fails to revert at at the end of a sweep.		
40. Measure the voltage at pin 8 (cathode) of V161. If the sweep has not started, the voltage should be +180 volts.	Proceed to step 41.	If voltage at pin 8 of V161 is higher than +180 volts, fault is in feedback loop consisting of V152 and V161. Proceed to step 42. If voltage is lower than 180 volts, proceed to step 43.
41. Check adjustment of the SWP. GATING MULTI. BIAS control (R176).	Sweep operates normally.	If SWP. GATING MULTI. BIAS control makes sweep free run but not trigger properly, check for possible absence of triggers. To make this check, proceed to step 44. If sweep does not start, check V45, V145 and associated circuitry.
42. Check tubes in feedback loop (V161 and V152).	Feedback circuit checks should be made. Proceed to If Abnormal column of this step and check resistors that are listed.	Check resistors R170, R172, R173, R163, R164 and R165. In addition, check R175 and SWP. GATING MULTI. BIAS control R176.
43. If the sweep has not reverted, the voltage at pin 8, V161 should be +40 volts.	Sweep should revert at +40 volts. V45B should be cutoff and V145A should be conducting. Proceed to step 44.	Check V152. If voltage at pin 8, V161 reads less than +40 volts (about +20 volts), V145 is defective or pin 2, V161 is shorted to ground. Check coaxial cable going to the DISPLAY switch SW160. Also, try other positions of the DISPLAY switch to see if trouble is in some positions only.
44. Check waveform at pin 7, V45B in the Type 527, or pin 2, V45B in the Type RM527. Positive-going trigger pulses should appear on the waveform.	Sweep triggers properly. Proceed to step 45 and check for presence of unblanking pulse.	Check back toward Sync Separator Multivibrator stage with oscilloscope. Check diode D44 and capacitor C44. Also, check adjustment of TRIG. MULTI. BIAS control (R39) according to instructions in Calibration procedure.

TABLE 5-2 (continued)

STEP	IF NORMAL	IF ABNORMAL
45. Check waveform at pin 1 (cathode) of V145B. Normal waveform unblanks the crt and permits waveform to be displayed.	Proceed to step 46 for final check of sweep sawtooth waveform.	
46. Check waveform at pin 8, V161 for final check on waveform linearity.	Sweep Generator operates normally.	If sweep is nonlinear, check for defective timing capacitors. Rotate DISPLAY switch one position at a time to isolate cause. Check V161.
Horizontal Amplifier		
47. Check waveform and its dc level at pin 2, V343.	Proceed to step 48.	Check setting of HORIZONTAL POSITION control (wiper arm voltage should be —70 volts) and check V343. If waveform is nonlinear make further checks in this circuit.
48. Check waveforms and their dc level at pins 1 and 6, V374.	Proceed to step 49.	Check V374 and voltages.
49. Check waveforms and their dc level at pins 6 and 1, V384.	Horizontal Amplifier normal (with possible exception of CPXR circuit). To check CPXR circuit, proceed to step 50.	Check V384 and voltages.
50. Apply a proper amplitude colorplexer signal (CPXR, 20-cycle staircase) to CPXR INPUT connector. DISPLAY switch must be set to RGB FIELD or LINE.	Circuit operates correctly.	Check V343 and associated circuitry.

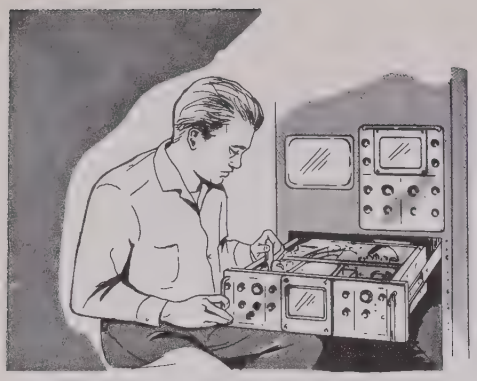


(a) Left side view, Type 527, rear portion.

(b) Bottom view, RM527, center portion

Fig. 5-3. Method 1 for disabling the DC Restorer action.

NOTES



SECTION 6

CALIBRATION

This section of the manual contains a checking and calibrating procedure for the instrument. The steps in this procedure are arranged in a sequence to avoid unnecessary repetition. The procedure should be performed after each 500 hours of operation, or every 6 months (if used intermittently).

The instructions that follow also furnish an orderly approach for the isolation of malfunctions which may develop. Consequently, this procedure may be used in conjunction with any maintenance and troubleshooting system.

Test equipment used in a particular step should be left connected at the end of that step, unless instructions state otherwise. Similarly, controls not mentioned are assumed to be in the positions they were in at the conclusion of the preceding step.

EQUIPMENT REQUIRED

The following equipment is required to perform a complete calibration of the instrument.

(1) Test oscilloscope having a +Gate Output connector and these specifications: bandpass dc to 10 mc; vertical deflection factor of at least 0.05 volts/cm (0.005 volts/cm, ac-coupled, preferred for step 4 power-supply ripple measurements).

(2) Tektronix P6001 or P6027 Probe or equivalent (1X "straight-through" probe; no attenuation). A 24" to 36" length of coaxial cable, with a UHF connector on one end, may be used in lieu of the probe. A 24" to 36" test lead, with a banana plug on one end, may also be used.

(3) Tektronix P6017 Probe or equivalent (bandpass, dc to 10 mc; attenuation, 10X; input capacitance, approximately 14 pf.)

(4) Sine-wave generator, Tektronix Type 190B Constant-Amplitude Signal Generator, or equivalent. Required specifications: output frequencies of 50 kc, and a range variable from 350 kc to 9 mc; output amplitude of approximately 10 volts, adjustable (manually or automatically) for constant amplitude at the frequencies stated.

(5) Calibrated VOM. Sensitivity of 20,000 ohms/volt at full deflection. Calibrated for an accuracy of at least 1% at 140 and 280 volts, and for an accuracy of at least 3% at 3800 volts.

(6) A precision differential voltmeter. A high-impedance, extremely accurate voltmeter is required for setting the Type 527 calibrator (step 16) for 1-volt output (±1%). A John Fluke Differential Voltmeter, or a Tektronix Type Z Plug-In Unit (Calibrated Differential Comparator) and a Type 530-, 540-, or 550-Series Oscilloscope recommended.

(7) Video signal source; signal amplitude, 1 volt.

(8) Variable autotransformer (e.g., Powerstat or Variac) having a rating of least 400 volt-amperes.

(9) Accurate rms-reading ac voltmeter, having a range of 0-150 volts (0-250 volts for 234-volt operation).

(10) 75-ohm 10-to-1 "T" attenuator, Tektronix Part No. 011-010.

(11) 75-ohm terminating resistor, Tektronix Part No. 011-023.

(12) Suggested tools: screwdriver having a shank 3½" long by 3/32" in diameter; low-capacitance screwdriver, Tektronix Part No. 033-000; 1/16" hexagonal wrench; Walsco No. 2543 double-ended 0.1" hexagonal wrench, Textronix Part No. 003-301; alignment tool consisting of a handle (Tektronix Part No. 003-007) and a hexagonal core insert (Tektronix Part No. 003-310).

ADJUSTMENT PROCEDURE

Preliminary

Connect the Type 527 to the autotransformer output. Use the ac voltmeter to monitor the output voltage of the autotransformer. Turn on the Type 527 and the test oscilloscope. Adjust the autotransformer to the design-center voltage for which your instrument is wired (117 or 234 volts) and allow at least 5 minutes warmup before making any adjustments.

Preset the Type 527 front-panel controls as follows:

CALIBRATOR	.714
INPUT	A
RESPONSE	IRE
GAIN	Switch to HIGH and rotate GAIN control fully counterclockwise.
MAGNIFIER	X1
DISPLAY	2 LINE
EXT.-INT SYNC.*	INT.

* Located on rear panel of some instruments.

1. Low-Voltage Power Supplies

Measure the output voltage of the —140-, +140-, and +280-volt supplies with a dc voltmeter (be sure your meter is accurate). Use the following information.

VOLTAGE MEASUREMENTS

SUPPLY	TOLERANCE	TEST POINT LOCATION	
		For TYPE 527*	For TYPE RM527*
—140	1%	Junction of pin 7, V619 and and R622.	Junction of pin 7, V619 and and R622.
+140	3%	Junction of R623 and R626.	Pin 3 of V657.
+280	3%	Junction of pin 2, V677 and R653.	Junction of pin 2, V677 and R670.

The +140-volt and +280-volt supplies depend on the —140-volt supply. If the —140-volt supply is out of tolerance, adjust the —140V adjustment (R636) for reading of exactly —140 volts on the voltmeter.

Check the +140- and +280-volt supplies to see that they are within their specified tolerances.

2. Check Regulation of Low-Voltage Power Supplies

To check the power supplies for regulation, vary the autotransformer voltage between 105v and 125v (or from 210v to 250v, if the power transformer is connected for 234-volt operation). All of the supply voltages should remain constant.

Disconnect the dc voltmeter.

3. Check Low-Voltage Power Supplies for Ripple

Set the test oscilloscope vertical deflection factor to 0.05 volts/cm (0.005 preferred, if oscilloscope has this deflection factor), ac coupled, and the sweep rate to 10 millisec/cm. Set the trigger controls to free run the sweep. Connect a 1X or "straight through" probe from the test oscilloscope to the —140-, +140- and +280-volt test points (given in step 1) and measure the ripple amplitude at low line and high line at each of the test points. The ripple amplitude should measure less than 20 millivolts at nominal line on each of the supplies; at low and high line the ripple amplitude should be less than 30 millivolts. Disconnect the 1X probe from the Type 527 and from the test oscilloscope. Set the autotransformer to the design-center voltage.

4. High-Voltage Power Supply

Connect the VOM between ground and the junction of B847 and R847. Adjust the —3800 V control for a meter reading of —3800 volts. Again vary the autotransformer between low and high line; the high voltage should remain essentially constant over the range. Reset the autotransformer to the design-center voltage. Disconnect the voltmeter.

5. Trigger Multivibrator Bias

Connect a video signal to one of the VIDEO INPUT A connectors. Connect a short jumper lead from the other VIDEO INPUT A connector to one of the VIDEO INPUT B connectors. Set the INPUT selector switch to A and the DISPLAY switch to 2 FIELD.

NOTE

In the steps that follow, test oscilloscope "vertical deflection factor" refers to the setting of the oscilloscope vertical amplifier VOLTS/CM switch times the probe attenuation. (Example: To obtain a vertical deflection factor of 1 volt/cm using a 10X probe, set the oscilloscope VOLTS/CM switch to .1).

Set the test oscilloscope vertical deflection factor to 1 volt/cm, dc coupled, and the sweep rate to 10 μsec/cm. Set the trigger controls to +Internal. Connect the cable end of the 10X probe to the oscilloscope vertical input connector. Free run the sweep, ground the probe tip, and position the trace two centimeters above the graticule centerline to establish a zero-voltage reference line. Connect the 10X probe tip to the junction of R29 and R31. Adjust the oscilloscope controls for triggered sweep. Note that the video signal is inverted, and the horizontal sync pulse tip is approximately 0.25 volt above ground (zero reference).

Horizontally position the center of the sync pulse to the center of the graticule and set the oscilloscope Magnifier switch to the X5 position. Adjust the TRIG. MULTI. BIAS adjustment (R39) to obtain the display illustrated in Fig. 6-1.

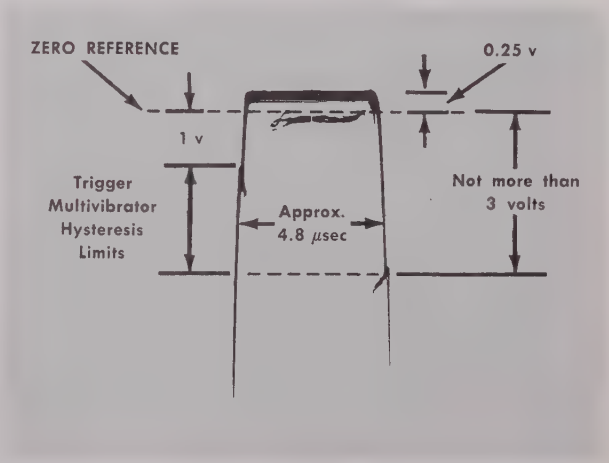


Fig. 6-1. Horizontal sync pulse obtained at the junction of R29-R31, when the TRIG. MULTI. BIAS adjustment is set correctly.

* The location of all test points and adjustments will be found on the pull-out illustration pages near the rear of the manual.

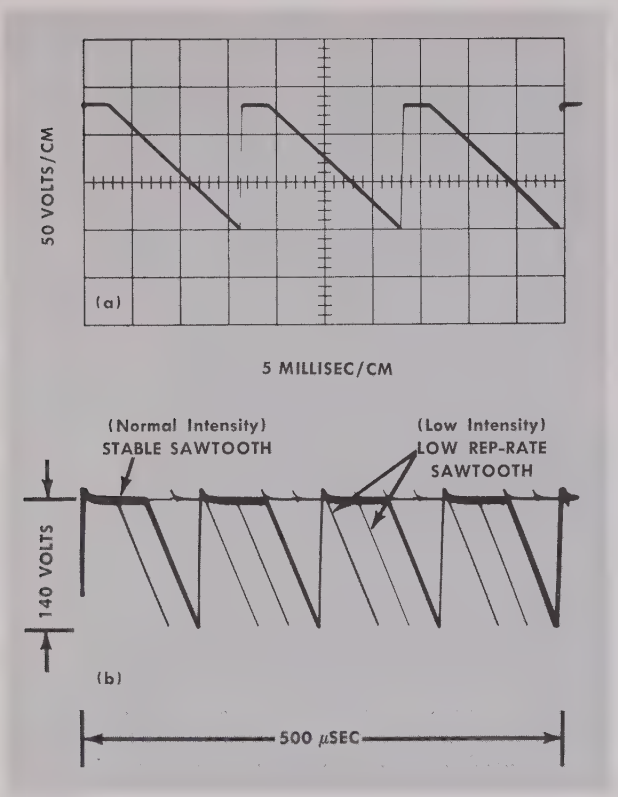


Fig. 6-2. Typical waveforms obtained when the SWP. GATING MULTI. BIAS adjustment is set correctly. (a) DISPLAY switch set to RGB FIELD; (b) DISPLAY switch set to RGB LINE.

6. Sweep Gating Multivibrator Bias

Set the oscilloscope vertical deflection factor to 50 volts/cm, dc coupled, the Magnifier switch to Off or Normal, and the sweep rate to 5 millisec/cm. Connect the 10X probe to pin 8, V161. Set the Type 527 DISPLAY switch to the RGB FIELD position. For a preliminary setting of the SWP. GATING MULTI. BIAS adjustment (R176), rotate the control fully clockwise. Then rotate the control slowly counterclockwise until a sawtooth waveform is displayed on the test oscilloscope [see Fig. 6-2 (a)]. Then rotate the control about 5° further counterclockwise. Check for a sawtooth waveform when the DISPLAY switch is set to the 2 FIELD and VIT positions. While the DISPLAY switch is set to the VIT position, set the INPUT switch to CAL. and check for a sawtooth on the oscilloscope. Then set the INPUT switch to the A position.

Set the oscilloscope for a sweep rate of 50 μsec/cm. Check for a sawtooth on the oscilloscope when the Type 527 DISPLAY switch is in the RGB LINE, 2 LINE, and .125H/CM positions of the DISPLAY switch. Overlook the low repetition rate (low intensity) sawtooth waveforms that appear when the Type 527 triggers on the equalizing pulses, as shown in Fig. 6-2 (b).

If a stable display is obtained, the SWP. GATING MULTI. BIAS control needs no further adjusting. If the sweep stops or free runs when checking for the sawtooth waveform, readjust the SWP. GATING MULTI. BIAS control to obtain a stable display approximately in the middle of the control's stable range. If the control is readjusted, recheck all positions of the DISPLAY switch to be sure that a sawtooth is displayed on the oscilloscope (indicating that the Type 527 sweep generator functions properly when triggered by incoming pulses).

Disconnect the 10X probe.

7. Horizontal Gain

Set the DISPLAY switch to the 2 FIELD position. Adjust the HORIZ. GAIN control (R375) for a sweep length of 10 centimeters on the Type 527 screen. Use the POSITION controls to position the back-porch level of the sync pulses at 0 IRE on the graticule so that the sweep length can be easily determined.

8. Astigmatism

Set the DISPLAY switch to the 2 LINE position and the INPUT selector switch to CAL. Set the VERTICAL POSITION control to midrange. Adjust the ASTIG. control (R864) in conjunction with the FOCUS control to obtain focus of the trace at the lower corners of the calibrator pulses.

9. Preliminary Setting of C160C

Set the INPUT selector switch to the A position. Adjust C160C for a stable display (sweep should not free run) in the 2 LINE and both RGB positions of the DISPLAY switch.

10. Horizontal Sweep Linearity

Rotate the DISPLAY switch between 2 LINE and 2 FIELD. Adjust C320 for the same sweep starting point in both positions of the switch.

11. Final Setting of C160C

Adjust C160C so that the second line horizontal sync pulse is centered on the second vertical sync pulse when the DISPLAY switch is moved from the 2 LINE to the 2 FIELD position.

12. 0.125H/CM Sweep Rate

Set the DISPLAY switch to the .125H/CM and RESPONSE switch to FLAT. Adjust C160G so that identical points on the line sync pulses are 8 centimeters apart.

13. X5 Magnifier

Set the MAGNIFIER switch to the X5 position. Adjust the INTENSITY control for suitable trace brightness. Position the display to the right with the HORIZONTAL POSITION control so that the sweep starts at the left side of the graticule. While switching the DISPLAY switch between the 2 LINE and 2 FIELD positions, adjust C334 so that the sweep starts at the same point.

14. X25 Magnifier

Set the MAGNIFIER switch to the X25 position. Adjust the INTENSITY control for suitable trace brightness. Position the display to the right with the HORIZONTAL POSITION control so that the sweep starts at the left side of the graticule. While switching the DISPLAY switch between the 2 LINE and 2 FIELD positions, adjust C336 for the same sweep starting point.

15. Sweep-Magnifier Registration

Set the DISPLAY switch to 2 FIELD. Horizontally position the trace so that the sweep starts at the center of the graticule. Set the MAGNIFIER switch to X1. Adjust the INTENSITY control for normal trace brightness, and adjust the SWP./MAG. REGIS. control (R355) so that the sweep starts at the center of the graticule.

16. Calibrator Amplitude

Set the INPUT selector switch to CAL., the CALIBRATOR to 1.0, and the DISPLAY switch to 2 LINE.

Two methods for accurately adjusting the calibrator amplitude are described: the Tektronix Z-Unit method and the voltmeter method.

To use the Z-Unit method, install the Type Z Plug-In Unit in a Tektronix plug-in type oscilloscope (530-, 540-, or 550-Series). Connect the 10X probe from the Z-Unit to the junction of R882 and R884. Set the oscilloscope vertical deflection factor to 0.5 volts/cm, and obtain a stable display on the oscilloscope. Remove the Type 527 CALIBRATOR knob, then use the $^3/_{32}$" diameter screwdriver to reach the CAL. AMPL. control (R886) through the hollow shaft of the CALIBRATOR switch. Adjust the CAL. AMPL. control so the amplitude of the signal is exactly 1 volt, peak-to-peak. Use the Z-Unit comparison voltage to determine if the amplitude is set accurately. Disconnect the probe from the Type 527 and reinstall the CALIBRATOR knob.

To use the voltmeter method, turn off the instrument and remove V800 to disable the high-voltage oscillator. Turn the instrument back on, set the precision dc voltmeter for 1.000 volt, connect the voltmeter to the junction of R882 and R884, and adjust the CAL. AMP. control (R886) for null reading on the meter.

NOTE

The operation of the calibrator is such that when the voltmeter method is used, the calibrator voltage will tend to be low. Therefore, the voltmeter reading should actually be 1 to 3 millivolts higher than the 1-volt setting previously given. The CAL. AMPL. control should never be set for a meter reading of less than 1 volt.

Turn the instrument off, disconnect the voltmeter, return V800 to its socket and turn on the power. Reinstall the CALIBRATOR knob.

17. Input Attenuator Compensation

Set the DISPLAY switch to 2 LINE and the GAIN control to the LOW range. Use the HORIZONTAL POSITION control to position the display to start at the left side of the graticule. Use the VERTICAL POSITION control to position the bottom of the calibrator pulses to the 0 IRE graticule line. Adjust the GAIN control so the calibrator pulses are approximately 80 IRE units in amplitude. Adjust C406 for a flat-topped calibrator waveform on the Type 527 screen.

18. A-B Differential

With a video signal still applied (steps 5 through 17) to the VIDEO INPUT A and B connectors, set the INPUT selector switch to A-B and rotate the GAIN control fully clockwise with the GAIN switch remaining in the LOW position. Adjust C506 for best signal rejection; i.e., for a straight line, as observed on the Type 527 screen.

19. CRT Beam Rotator

Adjust the CRT BEAM ROTATOR control (R860) so that the horizontal trace aligns with the 0 IRE graticule line.

20. DC Balance

With the trace aligned with the 0 IRE graticule line, adjust the DC BAL. control (R432) for minimum trace movement while rotating the GAIN control through its low range. Disconnect the video signal from the A and B connectors.

21. External Negative Sync Input Compensation

Apply a 1-volt calibrator signal from the test oscilloscope to the EXT. NEG. SYNC. INPUT connector. Set the INT.-EXT. SYNC. switch to EXT., and remove V35 from the socket. Set the oscilloscope vertical deflection factor to 10 volts/cm and the sweep rate to 0.5 millisec/cm. Connect the 10X probe to pin 5 of V24 and adjust the oscilloscope triggering controls for a stable display. Adjust C1 for best square corner (minimum overshoot or undershoot) at the top of the waveform, as observed on the oscilloscope. Disconnect the probe and return V35 to its socket.

22. Check Vertical Compression and Expansion

Set the oscilloscope calibrator for a 50-millivolt output. Disconnect the calibrator signal from the EXT. NEG. SYNC. INPUT connector and connect it to the VIDEO INPUT B connector. Set the INT.-EXT. SYNC. switch to INT. Set the INPUT selector switch to B and the DISPLAY switch to 2 FIELD. Set the GAIN control to HIGH and rotate the control until the waveform is 10 IRE units in amplitude. Position the waveform first to the top of the graticule and then to the bottom. The amplitude of the waveform should not change more than approximately one trace width, or 0.14 IRE unit, as the waveform is positioned vertically within the graticule limits.

23. Check Vertical Amplifier Sensitivity

Rotate the GAIN control fully clockwise and check the amplitude of the waveform; it should be at least 20 IRE units. Set the GAIN control to LOW and rotate the GAIN control fully counterclockwise.

Increase the test oscilloscope calibrator signal to 500 millivolts. The amplitude of the waveform displayed on the Type 527 should be 30 IRE units or less.

Disconnect the test oscilloscope calibrator signal.

24. High-Frequency Compensations

Connect a test lead from the test oscilloscope +Gate Output connector to the EXT. NEG. SYNC. INPUT connector, and set the INT.-EXT. SYNC. switch to EXT. Connect the 10X probe to the center tap on L500 to trigger the test oscilloscope. Set the oscilloscope vertical deflection factor to 0.5 volts/cm and the sweep rate to 20 μsec/cm.

Apply a 5-mc, 10-volt signal from the Constant-Amplitude Signal Generator through a 10-to-1 "T" attenuator to the VIDEO INPUT B connector. Terminate the other B connector with a 75-ohm termination. Check to see that the RESPONSE switch is set to FLAT. Set the DISPLAY switch to 2 LINE. Adjust the test oscilloscope for triggered-sweep operation. Adjust the Type 527 GAIN control for approximately 80 IRE units vertical deflection.

Adjust L421 and L521, in equal increments, for maximum signal amplitude on the Type 527 screen. Then, adjust L442 and L542, in equal increments, for maximum signal amplitude. Set the generator frequency to 50 kc and adjust the oscilloscope controls, if necessary, to obtain a stable display. Adjust the Type 527 GAIN control for an amplitude of 100 IRE units.

Increase the generator frequency to 5 mc. Adjust L462 and L562 to obtain 100 IRE units amplitude of the displayed signal.

25. Check Bandpass

Set the signal generator for a frequency of 50 kc, and check to see that the waveform displayed on the Type 527 screen is still 100 IRE units in amplitude. Then set the generator frequency to 350 kc. The amplitude should remain 100 IRE units. Increase the generator frequency to 5 mc. The amplitude should not change more than 1% out to 5 mc.

Increase the generator frequency to 9 mc. The amplitude of the display should be at least 70.7 IRE units (3-db point).

Decrease the generator frequency to 350 kc and set the RESPONSE switch to IRE. The amplitude of the display should be at least 98 units (not more than 2% down).

Set the generator frequency to 3.58 mc. The amplitude should not be more than 10 IRE units (20-db down).

The Type 527 is now calibrated. Disconnect all test equipment.

NOTES

SECTION 7

ACCESSORIES

Introduction

This section of the manual contains accessories and test equipment specifically used with the Type 527 and RM527 Waveform Monitors. Characteristics of other television oscilloscopes are also included.

Part I describes standard and optional accessories available for use with the Type 527 and RM527. Part II describes recommended test equipment and related accessories that can be used with the equipment. These accessories are useful when performing maintenance and calibration procedures. Part III describes other types of television oscilloscopes manufactured by Tektronix.

PART I
STANDARD AND OPTIONAL ACCESSORIES

CATHODE-RAY TUBES

Phosphors

A Tektronix Type T527P1 crt, part number 154-314, is normally supplied with the Type 527 and RM527. Any commercially available phosphor, however, can be provided on order. Some phosphors, such as the P12, P13, P19 and P26, are not recommended due to their great tendency to burn.

Phosphors other than those of short persistence may display an initial fluorescence of one color, followed by a phosphorescence of the same or another color. The following table describes some of the phosphors available.

PHOSPHOR CHARACTERISTICS

Phosphor	Fluorescence	Phosphorescence	Persistence
P1	Green	Green	Medium
P2	Blue-Green	Green	Long
P7*	Blue-Green	Yellow	Long
P11	Blue	Blue	Short
P15	Green-Blue	Green-Blue	Extremely Short
P31	Green	Yellow-Green	Medium

*Double-layer type.

GRATICULES

The following graticules are available. Type 527 and RM527 graticules are not interchangeable; therefore, use care when specifying the part number.

Graticule	Tektronix Part No.	
	Type 527	Type RM527
Standard (normally supplied): Scribed in 10-IRE-unit increments from —40 to +100. Also has a +7½% setup reference line.	331-069	331-068
Noncomposite IRE, +7½% setup.	331-079	331-077
% Video Modulation	331-080	331-078

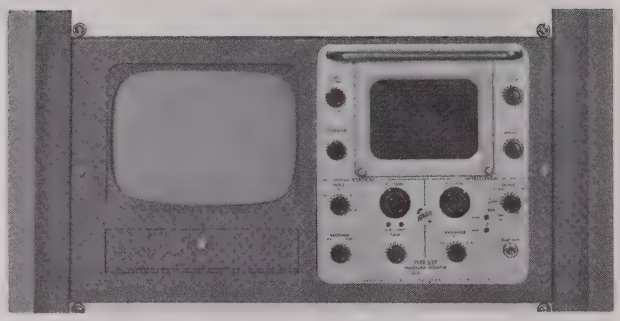
LIGHT FILTER

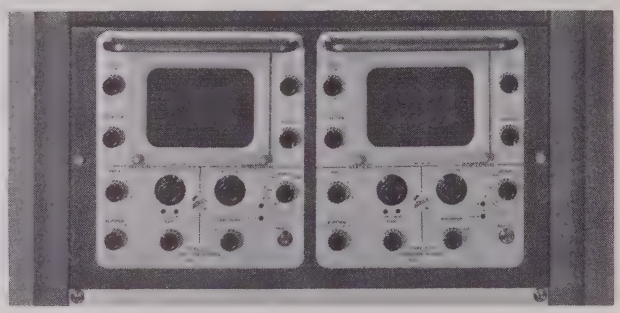
Under high ambient light conditions a light filter of the same color as the trace is useful to increase the contrast between the trace and the crt. The color of the standard filter supplied with the instrument is green and is used in conjunction with the T527P1 crt. .... Part No. 378-525

TYPE 527 RACK-MOUNTING CRADLE ASSEMBLIES

The following kits permit variations in mounting the Type 527 in a standard 19-inch rack or console. Each kit contains all necessary mounting hardware including a supporting cradle or "shelf" and an appropriate mask to fit around the front panels of the instruments. Standard finish is dark grey umber.

For cradle mounting the Type 527 on the left side of a commercial picture monitor ..... Part No. 426-133
For cradle mounting the Type 527 on the right side of a commercial picture monitor. ..... Part No. 426-134
For cradle mounting two Type 527's side by side on the same cradle. ..... Part No. 426-135





POWER CORD ADAPTOR

Additional power cord adaptors for operating the Type 527 or RM527 on a two-wire line can be ordered.
..... Part No. 103-013

TYPE 201 OSCILLOSCOPE TABLE

The Tektronix Type 201 Scope-Mobile® provides a mobile support for the Type 527 or other medium-size oscilloscopes and electronic instruments. Designed for the busy engineer, the easily adjustable (through nine 4.5° steps) tray places the instrument at desk height or at any convenient angle for optimum viewing. Mounted on 5-inch rubber-tired wheels, the Scope-Mobile oscilloscope table is easily moved around your work area.

SPECIFICATIONS

Adjustable Tilting Tray

Adjustable through six 4.5° steps in upward direction from the horizontal axis (desk height); three 4.5° steps in downward direction.

Tray Width

10½ inches (will hold Types 317, 515A, 516, and 527 oscilloscopes).

Bottom Shelf

Linoleum-topped shelf, 17½" x 26⅞"

Mechanical Features

Aluminum construction.
Handle and legs have anodized finish, other parts painted with tough blue vinyl.
Four 5-inch rubber-tired wheels.
Dimensions—approximately 17½" wide, 35" high, 27" deep.
Weight-approximately 35 pounds.

® Registered trademark, Tektronix, Inc.

TYPE 527 FIELD CASE

Converts your Type 527 for portable use. Field case dimensions: $9\frac{15}{16}$ inches high, $8\frac{7}{8}$ inches wide, and $17\frac{13}{16}$ inches deep. Order by description.

CAMERAS

TYPE C-12 CAMERA*

Interchangeable Lens—Lens easily changed by loosening two adjustable locknuts. Lenses available are f/1.5, f/1.9, or f/4.5.

Object-to-image ratios include 1:1, 1:0.9, 1:0.7 1:0.5.

Interchangeable Back—Accepts all standard Graflock accessories. Backs may be interchanged without refocusing.

Binocular Viewing—Orthogonal and undistorted over full 8 x 10 cm area.

Hinge Mounting—Camera swings away from crt screen for full visibility, lifts easily out of hinge fittings.

Rotating and Sliding Backs—Rotation through 90° steps. Horizontal and vertical movements of back through five positions.

Standard C-12 Camera shipped with f/1.9 Oscillo-Raptar lens having 1:0.9 object-to-image ratio, focusing 4 x 5 Graflok back, and Polaroid® roll-film back.

TYPE C-13 CAMERA*

Same style as the C-12 Camera except that it does not have the binocular viewing feature. Standard lens supplied with the C-13 Camera is an f/4.5 Oscillo-Amaton which has an object-to-image ratio of 1:0.7. Other lenses currently available from Tektronix will fit the C-13.

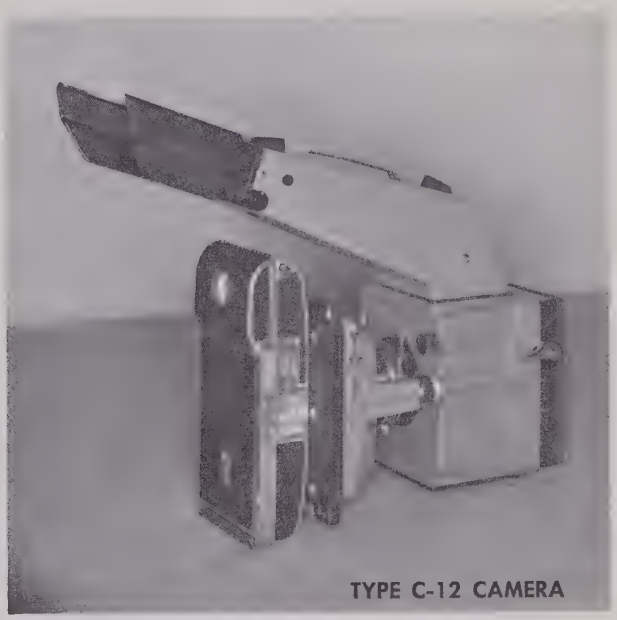
Other features of the C-13 Camera are similar to those of the C-12.

TYPE C-19 CAMERA*

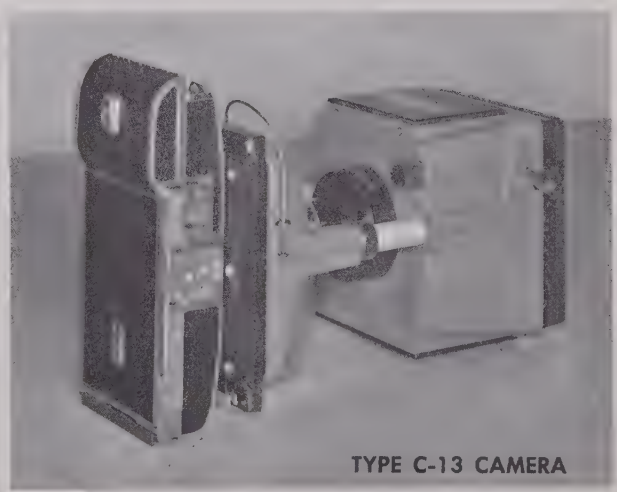
Same style as the C-12 Camera except that it is constructed without a beam-splitting mirror to permit maximum light from the oscilloscope screen to reach the camera lens. This feature in conjunction with the fast f/1.5 lens supplied with the camera make the C-19 particularly suitable for applications requiring extremely high writing rates. Other lenses currently available from Tektronix may be used with the C-19.

Binocular viewing of a 5 cm high by 10 cm wide screen area permits the oscilloscope display to be observed while being photographed.

Other features of the C-19 Camera are identical with those of the C-12.



TYPE C-12 CAMERA



TYPE C-13 CAMERA

*When ordering your camera, specify that you intend to use it with the Type 527 or RM527. This will insure that you will receive the correct mounting adaptor and series-150 lens assembly to fit the camera to your instrument.

® Registered trademark of the Polaroid Corp.

PART II
TEST EQUIPMENT AND ACCESSORIES

OSCILLOSCOPES*

TYPE 321 SMALL PORTABLE OSCILLOSCOPE**

Transistorized for Battery, DC, or AC Operation.

Frequency Response—DC to 5 mc.

Risetime—70 nsec.

Vertical Deflection Factor—0.01 v/div. to 20 v/div. in 11 calibrated steps (div equals 1/4 inch), continuously variable to 50 v/div, uncalibrated.

Sweep range—0.5 μsec/div to 0.5 sec/div with accurate 5X magnifier.

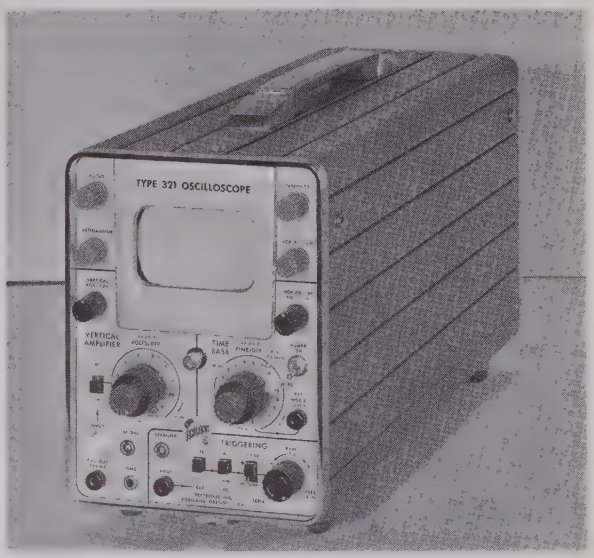
Triggering—Amplitude-level selection and automatic triggering.

Versatile Power Requirements—10 size D flashlight cells, or 10 size D rechargeable cells; 11.5 to 35 volts dc; 105 to 125 volts or 210 to 250 volts, ac single phase.

Dimensions—5¾" wide, 8¾" high, 16" deep.

*All oscilloscopes described herein except the Type 321 have positive gating pulses available at a front-panel +GATE OUT connector. These pulses are required to trigger the Type 527 or RM527 when adjusting the high-frequency compensation and checking the bandpass of the instrument.

**Useful for troubleshooting but not recommended for performing some of the steps in the calibration procedure where a wider bandwidth and a more versatile oscilloscope should be used.



TYPE 317 PORTABLE OSCILLOSCOPE

9-KV Accelerating Potential—Bright trace at low duty cycle sweeps.

Vertical Response—DC to 10 mc, 0.1 v/div to 50 v/div in 9 calibrated steps. 3 additional steps from 0.01 v/div to 0.1 v/div, at 2 cycles to 10 mc. Continuously variable from 0.01 v/div to 125 v/div.

Risetime—35 nsec.

Sweep range—0.2 μsec/div to 6 sec/div, with 22 calibrated steps.

Accurate 5X magnifier.

Triggering—Amplitude-level selection with preset or manual stability control, and automatic triggering.

Dimensions—8½" wide, 12" high, 19½" overall depth.

TYPE 316 PORTABLE OSCILLOSCOPE

1.85-KV Accelerating Potential. Identical to Type 317 in all other specifications.

TYPE RM16 and TYPE RM17 OSCILLOSCOPES

Mechanical rearrangements of Type 316 and Type 317 Oscilloscopes.

Same electrical characteristics. Slide-out mountings. Dimensions: 7" high, 19" wide, 17⅝" rack depth.

TYPE RS16—A two-unit model of the Type RM16 for racks of limited depth. Dimensions, Indicator—7" high, 19" wide, 11⅜" deep. Power Supply—7" high, 19" wide, 5⅛" deep. 60" power cable. Fixed mounting.

TYPE 515A PORTABLE OSCILLOSCOPE

Passband—DC to 15 mc.

Sensitivity—0.05 v/cm to 20 v/cm in 9 calibrated steps—continuously variable from 0.05 v/cm to 50 v/cm.

Risetime—23 nsec.

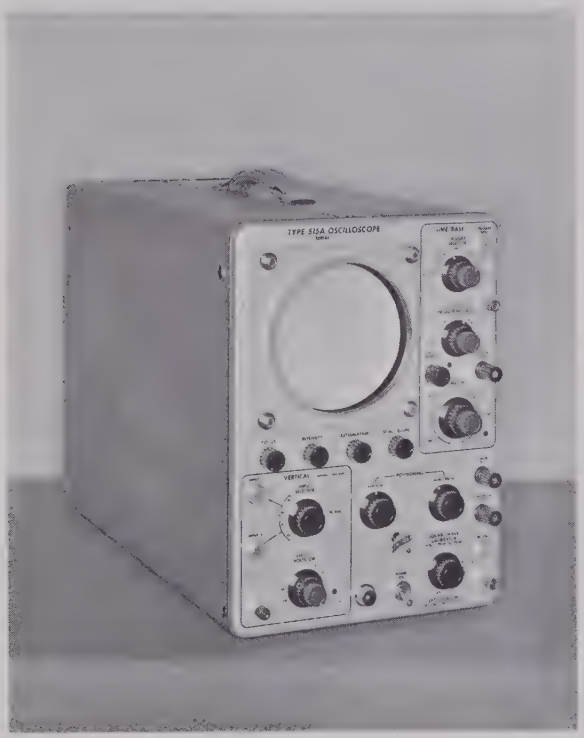
Sweep Range—0.2 μsec/cm to 6 sec/cm in 22 calibrated steps.

Accurate 5X magnifier.

Balanced 0.25μsec Delay Network.

Triggering—Amplitude-level selection with preset or manual stability control, and automatic triggering.

Dimensions—9¾" wide, 13½" high, 21½" deep.



TYPE RM15 RACK-MOUNTING OSCILLOSCOPE

A mechanical rearrangement of the Type 515A for rack-mounting.

The electrical characteristics of the Type RM15 are the same as the Type 515A.

Slide-out Mounting.

Dimensions—8¾" high, 19" wide, 22½" rack depth.

TYPE 516 DUAL TRACE OSCILLOSCOPE

Identical Vertical Input Channels—Passband, dc to 15 mc, risetime, 23 nanoseconds; sensitivity, 0.05 v/div to 20 v/div in 9 calibrated steps (div equals 1 cm), continuously variable to 50 v/div.

Four Operating Modes—Channel A, channel B, A and B chopped electronic switching at 150-kc rate, and A and B alternate.

Sweep range—0.2 μsec/div to 2 sec/div in 22 calibrated steps with accurate 5X magnification.

Versatile Triggering—Amplitude-level selection with preset or manual stability control, and automatic triggering.

Dimensions—9¾" wide, 13½" high, 21½" deep.

OSCILLOSCOPES WITH PLUG-IN PREAMPLIFIERS*

Inherent characteristics of these Tektronix Oscilloscopes permit their conversion for use with the Type 527 and RM527 through the use of interchangeable plug-in units.

The rack-mount types are attached to the cabinet on slide-out racks for servicing convenience. Dimensions—19" wide, 14" high, 22½" rack depth. Dimensions of the standard oscilloscope are: 13" wide, 16¾" high, 24" long.

***Positive gating pulses are available at the front-panel +GATE OUT connector for use when calibrating the Type 527 or RM527.**

Oscilloscopes and plug-ins having greater bandwidths are available for applications such as checking the flat-frequency performance of video circuits, video tape recorders, and for measuring multi-burst signal amplitudes. Contact your Tektronix Field Engineer or Representative for a catalog containing the full product line.

TYPE 535A WIDE-BAND OSCILLOSCOPE WITH SWEEP DELAY

Vertical Characteristics

DC to 15 mc passband, 23-nsec risetime, 50-mv/cm deflection factor with Type K Plug-In Preamplifier.

Plug-in units available to suit requirements.

Signal delay permits observation of leading edge of waveform that triggers the sweep.

Horizontal Characteristics

Two Time-Base Generators

Time Base A—0.1 μsec/cm to 5 sec/cm in 24 calibrated steps.

Continuously adjustable from 0.1 μsec/cm to 12 sec/cm.

5X magnifier increases calibrated range to 20 nsec/cm.

Single sweep provisions for 1-shot applications.

Time Base B—Also functions as delay generator. 2 μsec/cm to 1 sec/cm in 18 calibrated steps.

Sweep Delay—Two modes of operation.

Triggered—Delayed sweep started after the delay period by the signal under observation. Steady display, even of signals with inherent jitter.

Conventional—Delayed sweep started at the end of the delay period by the delayed trigger. Time jitter less than one part in 20,000.

Delay range—1 μsec to 10 sec in 18 calibrated ranges, each range divisible into 1000 parts by 10-turn control with incremental accuracy within 0.2%.

Other characteristics

10-KV Accelerating Potential—6-cm by 10-cm display.

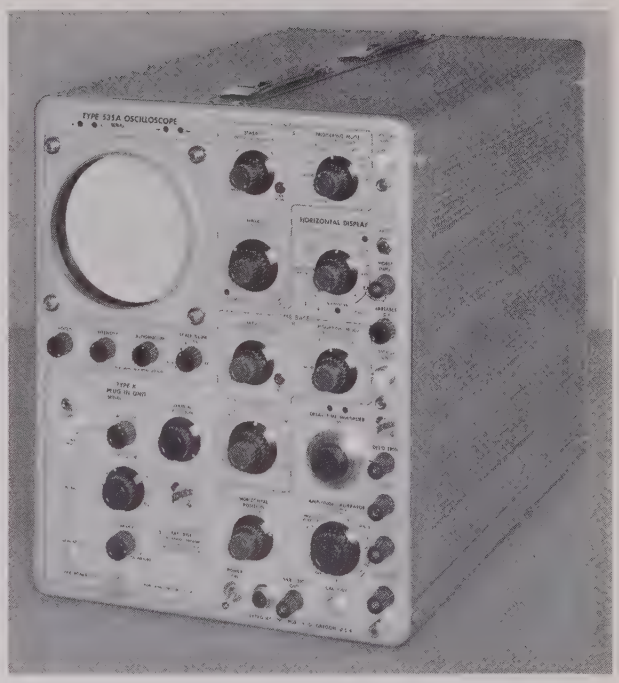
Dual-Trace Blanking—Eliminates switching transients from display when dual-trace unit is operated in chopped mode.

Amplitude Calibrator—0.2 mv to 100 v.

Electronically-regulated power supplies.

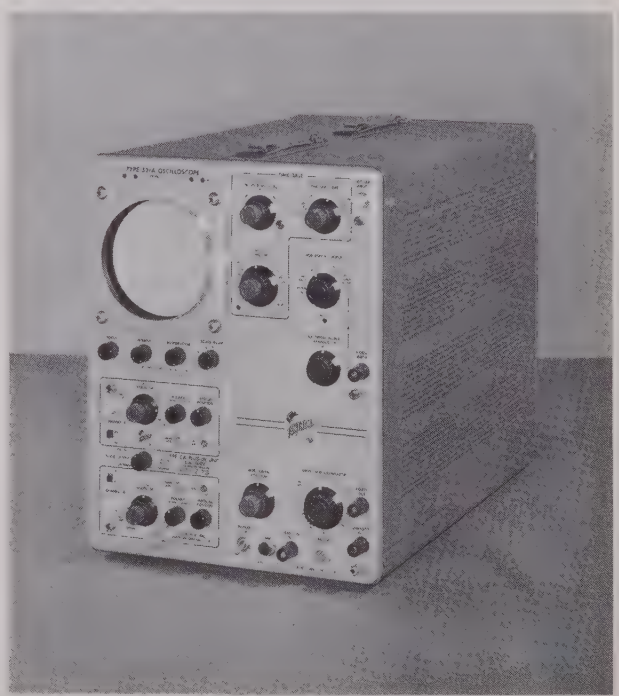
TYPE RM35A OSCILLOSCOPE

Electrically identical to the Tektronix Type 535A.



TYPE 531A WIDE-BAND OSCILLOSCOPE

Same as Type 535A except that it does not have Time Base B or provisions for sweep delay or single sweeps.



TYPE RM31A OSCILLOSCOPE

Electrically identical to the Tektronix Type 531A.

TYPE 532 OSCILLOSCOPE

DC to 5 mc Main Vertical Amplifier
70-nsec risetime with wide-band plug-in preamplifier units.
Sweep Range
21 calibrated sweep rates from 1 μsec/cm to 5 sec/cm.
5X magnifier extends calibrated range to 0.2 μsec/cm.
Continuously variable from 0.2 μsec/cm to 12 sec/cm.
Triggering
Amplitude-level selection with preset or manual stability control, and fully-automatic triggering.
4-KV Accelerating Potential
8 by 10 cm linear display.
Amplitude Calibrator
0.2 mv to 100 v in 18 steps. Square wave, frequency about 1 kc.
Electronically-regulated power supplies.

TYPE RM32 OSCILLOSCOPE

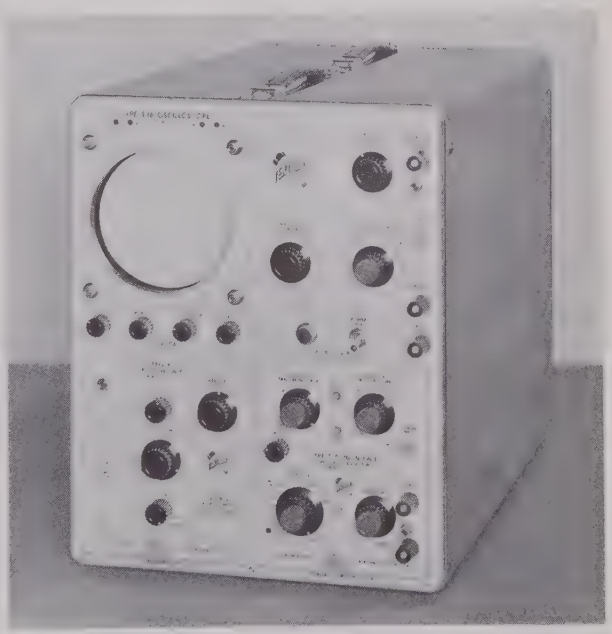
Electrically identical to the Tektronix Type 532.

TYPE 533A OSCILLOSCOPE

High Performance
DC to 15 mc, 23-nsec risetime with fast-rise plug-in preamplifier units.
0.2 μsec signal delay.
20 nsec/cm to 15 sec/cm sweep range.
Easy Operation
24 calibrated direct-reading sweep rates, 0.1 μsec/cm to 5 sec/cm.
Sweep Magnification—2, 5, 10, 20, 50, and 100 times.
Preset Triggering—Eliminates triggering adjustments in most applications.
Single-Sweep Operation—Lockout-reset circuitry for one-shot recording.
High Writing Rate
250 cm/μsec—10-kv accelerating potential assures bright trace for single sweeps and low repetition rates. 6-cm by 10-cm viewing area.
Electronically-Regulated Power Supplies

TYPE RM33A OSCILLOSCOPE

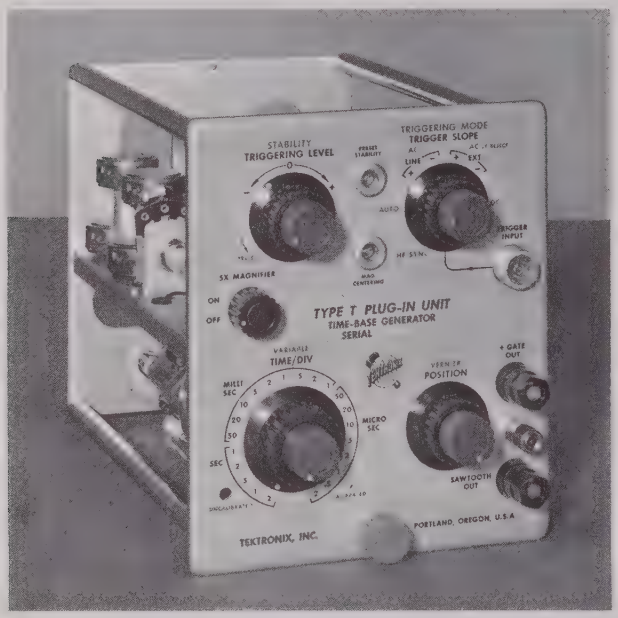
Electrically identical to the Tektronix Type 533A.



TYPE 536 "X-Y" OSCILLOSCOPE

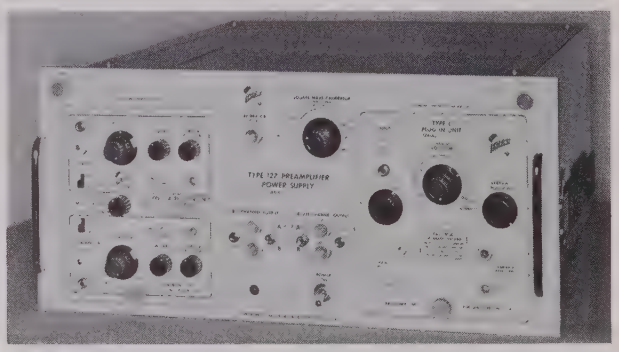
Identical Horizontal and Vertical Main Amplifiers
DC to 10 mc with Type G Differential Plug-In Preamplifiers.
Less than 1° relative phase difference from dc to 15 mc. Phase balance can be obtained at any one frequency to over 25 mc.
Converts to general-purpose oscilloscope with Type T Time-Base Unit plugged into horizontal amplifier.
4-KV Accelerating Potential
10 by 10 division viewing area.
Amplitude Calibrator
0.2 mv to 100 v in 18 steps. Square wave, frequency about 1 kc.
Electronically-Regulated Power Supplies.

Type T Time-Base Generator Plug-In Unit—Provides sweep voltages necessary for operating the Type 536 in usual oscilloscope applications. Generates 22 calibrated sweep rates from 0.2 μsec/div to 2 sec/div. 5X magnifier is accurate at all sweep rates. Triggering is fully automatic, or manual with amplitude-level selection and preset or manual stability control.



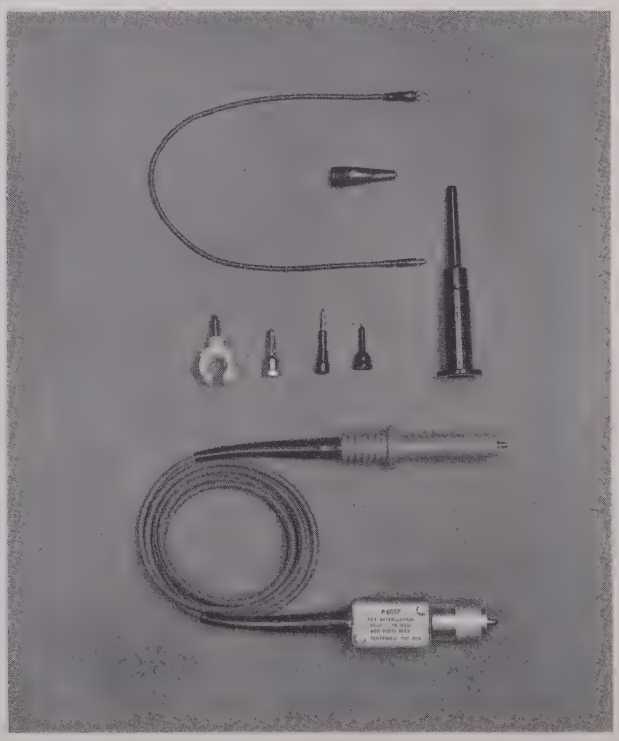
Type Z Differential Comparator Plug-In Unit—Vertical "magnification" up to 500 times. Sensitivity is 50 mv/cm, dynamic range is ±100 volts providing an effective scale length of ±2000 cm. Internal dc comparison voltages are 0 to ±100v (±0.15%); 0 to ±10v (±0.2%); 0 to ±1v (±0.25%). Besides differential comparator operation, the Type Z operates as a conventional amplifier and differential amplifier.

Type 127 Preamplifier Power Supply—A rack-mounting unit that supplies proper operating power to one or a combination of two Type A to Z Plug-In Units. Contains a differential dc-coupled amplifier stage with push-pull output. Risetime is 18 nsec. Square-wave amplitude calibration has 18 steps from 0.2 mv to 100 v. Dimensions—8¾" high, 19" wide, 20" rack depth.



PROBES

The most common method of connecting signals to a signal amplifier is to use a probe of appropriate attenuation. An attenuator probe significantly reduces the loading on the circuit being measured below the loading value of the signal amplifier input terminals.



The standard cable length 10X probes (Types P6017 and P6022) listed preserve the transient response of Tektronix fast-rise, wide-band oscilloscopes. These probes are free of overshoot and ringing and have a uniform amplitude response. Average bandpass characteristics show the 10X probes to be down between 0 and 1 db at 30 megacycles.

Longer cable lengths permit greater distances to be used between the test oscilloscope and the device under test, but frequency response of the probe will be less. A 12-foot 10X probe, for example, reduces the bandpass to 3 db down between 16 and 20 megacycles. Compensation of the 10X probes is accomplished by adjusting the variable capacitor located in the compensator box.

The 1X probes (Types P6027 and P6028) have no attenuation and are generally used for low-frequency measurements such as checking regulated power-supply ripple. These probes do not require a compensation adjustment.

The 10X and 1X probes are easy to handle, ruggedly constructed, and light weight. Physical dimensions of the probe body are $\frac{7}{16}$ inch in diameter and $3\frac{1}{4}$ inches in length without the tip. The standard cable length is 42 inches.

Four interchangeable tips—spring, hooked, pincher, and banana tip are included with the probe. A 12-inch ground lead is also included.

PROBE SPECIFICATIONS

Probe and Connector	Cable Length	Atten. Ratio	Input Impedance			Voltage Rating (Max.)	Part No.
			Resistance Meg Ω†	Capacitance—pf Min.*	Max.**		
P6017-UHF	42 inch††	10X	10	14	14	600	010-038
	6 foot	10X	10	17	17	600	010-056
	9 foot	10X	10	20	20	600	010-057
	12 foot	10X	10	23	23	600	010-058
P6022-BNC	42 inch††	10X	10	14	14	600	010-064
	6 foot	10X	10	17	17	600	010-066
	9 foot	10X	10	20	20	600	010-067
	12 foot	10X	10	23	23	600	010-068
P6027-UHF	42 inch††	1X	1	67	94	600	010-070
(Replaces	6 foot	1X	1	93	120	600	010-071
P6001-UHF	9 foot	1X	1	120	147	600	010-072
1X probe)	12 foot	1X	1	146	173	600	010-073
P6028-BNC	42 inch††	1X	1	67	94	600	010-074
(Replaces	6 foot	1X	1	93	120	600	010-075
P6004-BNC	9 foot	1X	1	120	147	600	010-076
1X probe)	12 foot	1X	1	146	173	600	010-077

†When connected to instruments with 1-megohm input resistance.

††Standard cable length

*When connected to instruments with 20-pf input capacitance.

**When connected to instruments with 47-pf input capacitance.

SIGNAL GENERATOR

TYPE 190B CONSTANT-AMPLITUDE SIGNAL GENERATOR

Output Frequency—350 kc to 50 mc, continuously variable, 50 kc reference signal.

Output Amplitude—40 mv to 10 v peak-to-peak, continuously adjustable.

Amplitude Variation—less than 2% from 50 kc to 30 mc; less than 5% from 30 mc to 50 mc.

Harmonic Content—Typically less than 5%.

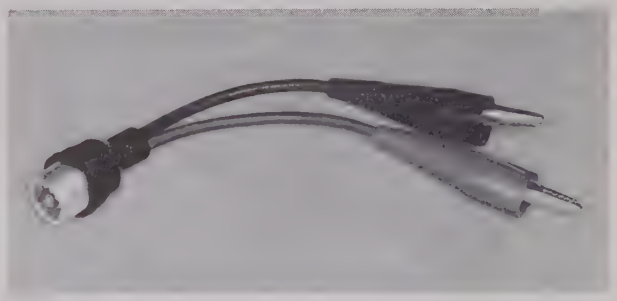
TEST ACCESSORIES

75-OHM COAX CABLE

75 ohms nominal impedance, 42 inches long.
..... Part No. 012-002

CLIP LEAD ADAPTOR

Adaptor, clip lead ..... Part No. 013-003



ATTENUATOR

75-ohm 'T' Attenuator, 10 to 1 voltage ratio, 1.5 w.
..... Part No. 011-010

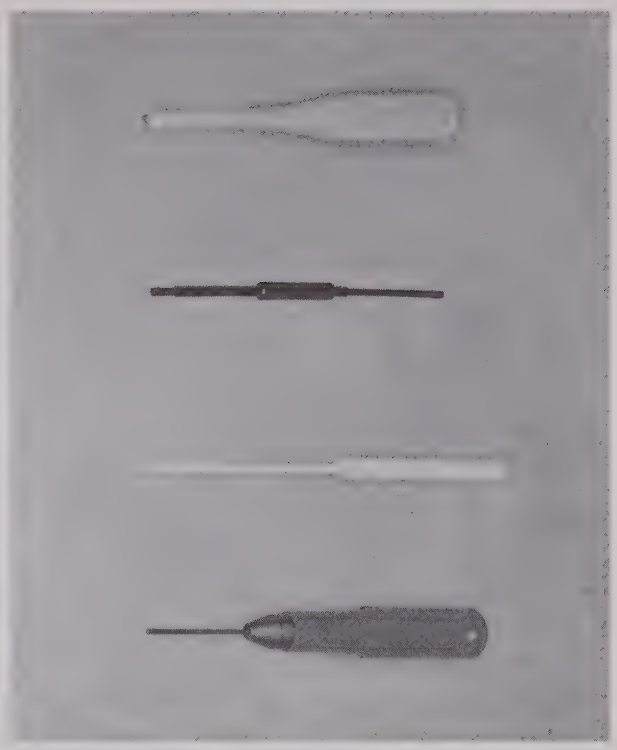
TERMINATION

75-ohm termination for Type 525, 0.5 w .. Part No. 011-023

RECALIBRATION TOOLS

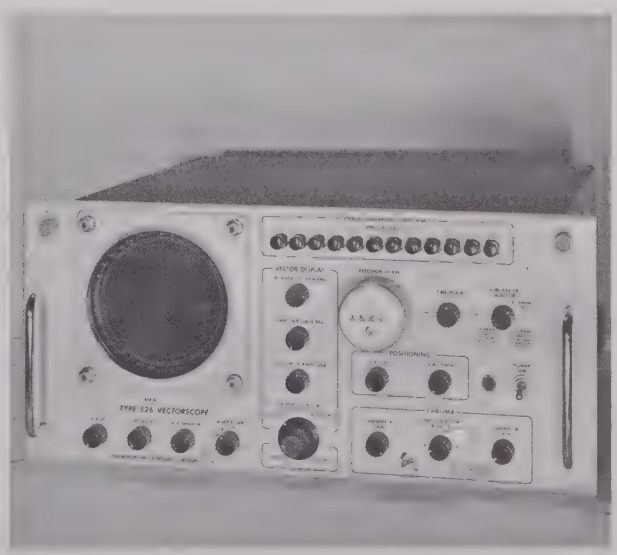
The tools indicated are recommended for use in calibrating the Type 527 or RM527. All tools except the assembly with part numbers 003-307 and 003-310 are available through most electronic part suppliers.

Description	Tektronix Part No.
Jaco No. 125 insulated low-capacitance screwdriver. Useful for making trimmer adjustments where a tool of minimum capacitance is needed.	003-000
Walsco No. 2543 double-ended 0.1" hexagonal wrench. A useful tool for adjusting 0.1" I.D. hexagonal slugs in the variable inductors.	003-301
Tektronix recalibration tool assembly. This 2-unit tool is useful for adjusting the 5/64" I.D. hexagonal slugs in the variable inductors. Handle	003-307
Hexagonal wrench insert, for 5/64" I.D. slugs	003-310
Hexagonal wrench, 1/16", useful for removing and replacing the CALIBRATOR knob when performing the Calibrator Amplitude adjustment step.	003-089



PART III
TELEVISION OSCILLOSCOPES

TYPE 526 VECTORSCOPE (for the N.T.S.C. Color-Television Signal)



Both Vector and Line-Sweep Displays

Phase Accuracy—±1.5° by vector presentation, ±1° by null technique.

Phase Resolution—Better than 0.1° at 3.58 mc.

Saturation Measurements—±2% on graticule, closer when comparing two signals.

Dual Displays—Electronically-switched dual input channels permit direct comparison between two signals.

Interfield Signal Key—Permits easy display of test signals during vertical blanking interval.

Linear Time Base—Operates at line rate, synchronized by horizontal sync pulse.

Burst Brightening—Positive identification of burst packet.

Push-Pull Synchronous Demodulators—DC-coupled to crt to prevent changes in chroma signal composition from affecting the positioning of the display.

Self-Checking Circuitry

Subcarrier Regenerator

TYPE 524AD TELEVISION OSCILLOSCOPE

Passband

Normal—DC to 10 mc from 0.15 v/cm to 50 v/cm, 2 cycles to 10 mc from 15 mv/cm to 50 v/cm.

Flat—Within 1% from 60 cycles to 5 mc.

IRE—Meets IRE standards for level measurements.

Risetime—35 nsec.

Sweep Range—Continuously variable, 0.1 μsec/cm to 0.01 sec/cm.

Time Markers—0.05 μsec, 0.1 μsec, 1.0 μsec, 200 and 40 pips per television line.

Sweep Delay—0 to 25 milliseconds, continuously variable.

DC-Coupled Unblanking.

3X and 10X magnifier.

Variable-Duty-Cycle Amplitude Calibrator.

TYPE 525 TELEVISION WAVEFORM MONITOR

Frequency Response

Flat—Within 1% between 60 cycles and 5 mc.

Low Pass— Passes stair steps, eliminates high frequencies.

High Pass—Passes high frequencies, eliminates stair steps.

IRE—Meets IRE standards for level measurements.

Sensitivity—Deflection factor of the vertical amplifier is 0.015 v/cm.

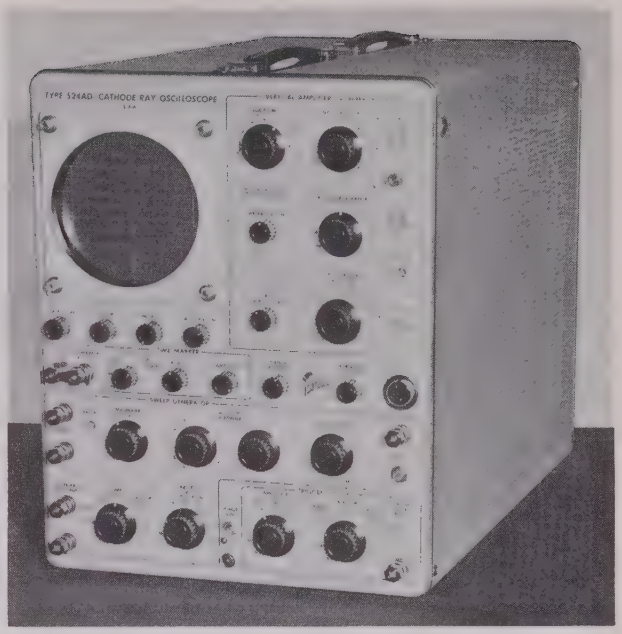
Vertical Attenuator—1X, 2X, and 5X.

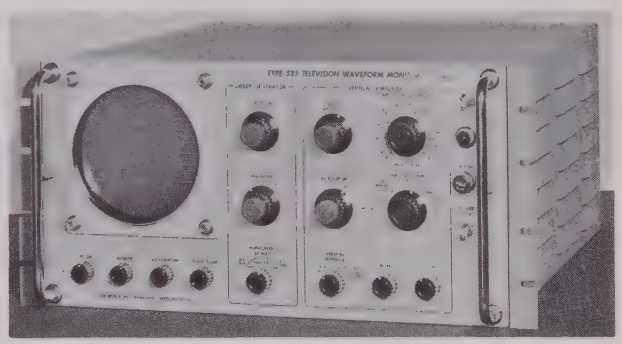
Keyed Clamp-Type DC Restorer.

Gain Stability within 1%.

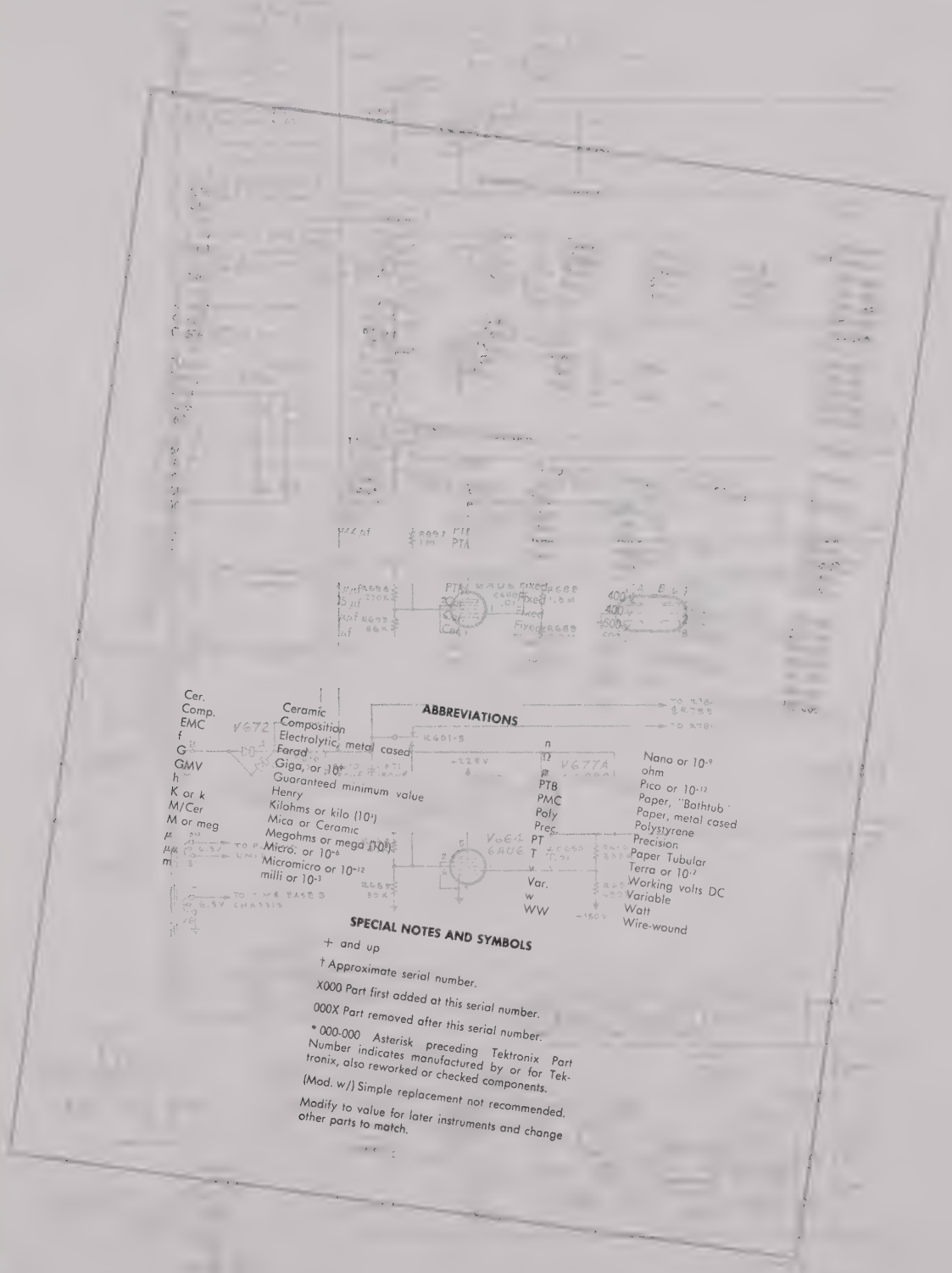
Rack-Mounting—8¾" high, 19" wide, 20¾" rack depth.

TYPE 525MOD111—Equipped with intensifier for observation of vertical-blanking-interval test signal.





PARTS LIST *and* DIAGRAMS



MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

HOW TO ORDER PARTS

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

PARTS LIST
TYPE RM527

Values are fixed unless marked variable.

Ckt. No.	S/N Range	Description					Tektronix Part Number
		Bulbs					
B338		NE-2	.025 H/CM				150-002
B339		NE-2	.005 H/CM				150-002
B405		NE-2				HIGH	150-002
B406		NE-2				LOW	150-002
B601		Incandescent #47 Grat. Light					150-001
B602		Incandescent #47 Grat. Light					150-001
B640		NE-2 Pilot Light				AC ON	150-002
B847		NE-23					Use 150-027
B848		NE-23					Use 150-027
		Capacitors					

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors are as follows:

3 V — 50 V = —10% +250%
51 V — 350 V = —10% +100%
351 V — 450 V = —10% +50%

C1	101-150	4.5-25 pf	Cer.	Var.			281-010
C1	151-up	7-45 pf	Cer.	Var.			281-012
C2	101-150X	22 pf	Cer.		500 v	10%	281-511
C3		0.1 μf	PTM		200 v		285-572
C4	X-151-up	22 pf	Cer.		500 v	10%	281-511
C7	101-150X	22 pf	Cer.		500 v	10%	281-511
C11		0.1 μf	Discap		500 v		283-008
C20		.1 μf	PTM		200 v		285-572
C26		100 μf	EMT		25 v		290-015
C29		.02 μf	Discap		600 v		283-006
C34		47 pf	Cer.		500 v	10%	281-519
C37		47 pf	Cer.		500 v	10%	281-519
C44		150 pf	Cer.		500 v		281-524
C48		4.7 pf	Cer.		500 v	±1% pf	281-501
C142		18 pf	Cer.		500 v		281-558
C160A		7500 pf	Mylar		400 v	1%	*291-032
C160C		4.5-25 pf	Cer.	Var.			281-010
C160D	X151-up	8 pf	Cer.		500 v	±0.5 pf	281-503
C160E		470 pf	Mica		500 v	10%	283-522
C160G		4.5-25 pf	Cer.	Var.			281-010
C178		.001 μf	Discap		500 v		283-000
C320		4.5-25 pf	Cer.	Var.			281-010
C321		18 pf	Cer.		500 v		281-558
C331		100 pf	Cer.		500 v	10%	281-530
C332		2000 pf	Mica		500 v	1%	283-555
C333		360 pf	Mica		500 v	±1%	283-567
C334		4.5-25 pf	Cer.	Var.			281-010
C336		4.5-25 pf	Cer.	Var.			281-010
C341		.001 μf	Discap		500 v		283-000
C345		.005 μf	Discap		500 v		283-001
C348		3900 pf	Mica			5%	283-531
C355		.01 μf	Discap		250 v		283-005
C404		12 pf	Cer.		500 v	10%	281-505
C406		1.5-7 pf	Cer.	Var.			281-005
C408		.005 μf	Discap		500 v		283-001

Capacitors *(continued)*

							Tektronix Part Number
C409		2.2 pf	Cer.		500 v	±0.5 pf	281-500
C411		.001 μf	Discap		500 v		283-000
C412		0.1 μf	PTM		200 v		285-572
C417		0.1 μf	PTM		200 v		285-572
C423		.001 μf	Discap		500 v		283-000
C428		.005 μf	Discap		500 v		283-001
C434	X332-up	24 pf	Cer.		500 v	5%	281-564
C435	101-331	150 pf	Cer.		500 v		281-524
C435	332-up	130 pf	Cer.		500 v	1%	283-053
C436	X332-up	24 pf	Cer.		500 v	5%	281-564
C437	101-331	150 pf	Cer.		500 v	1%	281-524
C437	332-up	130 pf	Cer.		500 v		283-053
C439	X210-up	.01 μf	Discap		150 v		283-003
C443		.001 μf	Discap		500 v		283-000
C448		.005 μf	Discap		500 v		283-001
C463		.001 μf	Discap		500 v		283-000
C468		.005 μf	Discap		500 v		283-001
C485		18 pf	Cer.		500 v		281-558
C504		12 pf	Cer.		500 v	10%	281-505
C506		1.5-7 pf	Cer.	Var.			281-005
C508		.005 μf	Discap		500 v		283-001
C509		2.2 pf	Cer.		500 v	±0.5 pf	281-500
C523		.001 μf	Discap		500 v		283-000
C539	X210-up	.01 μf	Discap		150 v		283-003
C543		.001 μf	Discap		500 v		283-000
C563		.001 μf	Discap		500 v		283-000
C582		100 pf	Mica			5%	283-506
C593		27 pf	Cer.		500 v	±1.35 pf	281-515
C595		.01 μf	Discap		250 v		283-005
C610		125 μf	EMC		350 v		*290-154
C612A,B		10 x 160 μf	EMC		350 v		*290-061
C614A,B		10 x 160 μf	EMC		350 v		*290-155
C621		.01 μf	PTM		400 v		285-510
C631		.01 μf	PTM		400 v		285-510
C661		.01 μf	PTM		400 v		285-510
C670A,B		2 x 10 μf	EMC		500 v		*290-152
C681		.01 μf	PTM		400 v		285-510
C803		.001 μf	Discap		500 v		283-000
C807		.001 μf	PTM		600 v		285-501
C808		900 pf	Mica		500 v	10%	283-525
C822		2500 pf	Discap		6000 v		283-036
C841		.02 μf	Discap		600 v		283-006
C842		2500 pf	Discap		6000 v		283-036
C850		.02 μf	Discap		600 v		283-006
C867		.001 μf	Discap		500 v		283-000

Diodes

			Tektronix Part Number
D4	X151-up	6045	152-045
D7	101-150	2607/T12G	152-008
D7	151-up	6045	152-045
D14		2607/T12G	152-008
D16		2607/T12G	152-008
D19	101-150	2607/T12G	152-008
D19	151-up	6045	152-045
D44		2607/T12G	152-008

Diodes *(continued)*

		Tektronix Part Number
D444	DR746/HD2948	152-007
D446	DR746/HD2948	152-007
D596	1N789	152-017
D610A,B	IN2862 (or equal)	(2) 152-047
D612A,B	IN2862 (or equal)	(2) 152-047
D614A,B,C,D	IN2862 (or equal)	(4) 152-047
D882	RT6	152-016

Fuses

F601	3 Amp 3 AG Fast-Blo 117 V operation		159-015
F601	1.5 Amp 3 AG Fast-Blo 234 V operation		159-016

Inductors

L1		100 mμh			*108-229
L34		Delay Line			119-014
L43		Delay Line			119-015
L400	101-398	Replacement Kit			Use *050-068
L400	399-up	Part of etched circuit board			*388-531
L421		11-23 μh	Var.	core 276-506	*114-110
L434		3.2 μh			*108-088
L435		130 μh			*108-234
L436		3.2 μh			*108-088
L437		130 μh			*108-234
L442		15-30 μh	Var.	core 276-506	*114-076
L460		3.2 μh			*108-088
L462		60-115 μh	Var.	core 276-506	*114-140
L500	101-398	Replacement Kit			Use *050-068
L500	399-up	Part of etched circuit board			*388-531
L505	X399-up	Ferramic suppressor			276-507
L521		11-23 μh	Var.	core 276-506	*114-110
L542		15-30 μh	Var.	core 276-511	*114-076
L560		3.2 μh			*108-088
L562		60-115 μh	Var.	core 276-511	*114-140
L860		Beam Rotator			*108-228

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R1		400 k	½ w	Prec.	1%	309-126
R3	101-150X	1.8 meg	½ w	Prec.	1%	309-020
R4	101-150	2.15 meg	½ w	Prec.	1%	309-275
R4	151-up	220 k	½ w			302-224
R7	X151-up	1.11 meg	½ w	Prec.	1%	309-015
R10		47 Ω	¼ w			316-470
R11		1 meg	¼ w			316-105
R13		68 k	½ w			302-683
R14		1 k	¼ w		5%	315-102
R15		22 k	1 w			303-223
R16		1 k	¼ w		5%	315-102
R17		47 Ω	¼ w			316-470
R18		68 k	½ w			302-683
R19	101-150	2.15 meg	½ w	Prec.	1%	309-275
R19	151-up	1.5 meg	½ w	Prec.	1%	309-017

							Tektronix Part Number
R20		1 meg	½ w	Prec.		1%	309-148
R21		100 Ω	¼ w				316-101
R23		4.7 k	2 w				306-472
R25		27 Ω	½ w				302-270
R26		56 Ω	½ w				302-560
R29		2.2 meg	½ w				302-225
R31		15 meg	½ w				302-156
R32		100 Ω	¼ w				316-101
R33		2.7 k	½ w			5%	301-272
R34		2.7 k	½ w			5%	301-272
R37		139.5 k	½ w	Prec.		1%	309-265
R38		100 k	½ w	Prec.		1%	309-045
R39		50 k		Var.		Trig. Multi. Bias	311-023
R40		18 k	2 w			5%	305-183
R41		100 Ω	¼ w				316-101
R43		2.1 k	½ w	Prec.		1%	309-117
R44		40 k	½ w	Prec.		1%	309-155
R45	101-150	1.2 meg	½ w	Prec.		1%	309-149
R45	151-up	800 k	½ w	Prec.		1%	309-110
R46		100 Ω	¼ w				316-101
R47		47 k	2 w			5%	305-473
R48		200 k	½ w	Prec.		1%	309-051
R49		72 k	1 w	Prec.		1%	310-113
R140		11 k	2 w			5%	305-113
R141		100 Ω	¼ w				316-101
R142		36 k	1 w			5%	303-363
R143		27 k	½ w			5%	301-273
R144		39 k	½ w				302-393
R145		100 Ω	¼ w				316-101
R148		56 k	2 w				306-563
R150		1 meg	½ w				302-105
R151		100 Ω	¼ w				316-101
R160		4 meg	1 w	Prec.		1%	310-103
R161		100 Ω	¼ w				316-101
R163		390 k	½ w				302-394
R164		56 k	½ w				302-563
R165		100 k	½ w				302-104
R167		100 Ω	¼ w				316-101
R168		100 Ω	¼ w				316-101
R170		45 k	1 w	Prec.		1%	310-093
R172		18 k	½ w	Prec.		1%	309-036
R173		15 k	1 w	Prec.		1%	310-115
R174	X151-up	18 k	¼ w				316-183
R175		27 k	½ w				302-273
R176		100 k		Var.		Swp. Gating Multi Bias	311-026
R178		1.8 meg	½ w				302-185
R179		75 Ω	½ w			5%	301-750
R320		1.55 meg	½ w	Prec.		1%	309-018
R321		1.5 meg	½ w	Prec.		1%	309-017
R323		50 k		Var.	WW	Horiz POSITION	Use 311-358

Resistors *(continued)*

							Tektronix Part Number
R330	5 meg	½ w	Prec.		1%		309-087
R332	27.4 k	½ w	Prec.		1%		309-339
R334	165 k	½ w	Prec.		1%		309-340
R338	470 k	½ w					302-474
R340	10 meg	½ w					302-106
R341	2.2 meg	¼ w					316-225
R343	100 Ω	¼ w					316-101
R344	5.6 k	½ w					302-562
R345	100 k	½ w					302-104
R347	62 k	½ w			5%		301-623
R348	16.69 k	½ w	Prec.		1%		309-231
R350	100 Ω	¼ w					316-101
R353	3.3 k	½ w					302-332
R354	47 k	1 w					304-473
R355	50 k		Var.		Swp./Mag. Regis.		311-224
R370	100 Ω	¼ w					316-101
R371	100 Ω	¼ w					316-101
R372	43 k	1 w			5%		303-433
R374	68 k	½ w			5%		301-683
R375	2.25 k		Var.		Horiz. Gain		311-071
R376	68 k	½ w			5%		301-683
R378	43 k	1 w			5%		303-433
R380	100 Ω	¼ w					316-101
R381	100 Ω	¼ w					316-101
R382	51 k	1 w			5%		303-513
R384	27 k	½ w			5%		301-273
R385	3.9 k	½ w			5%	Use	301-392
R386	27 k	½ w			5%		301-273
R388	51 k	1 w			5%		303-513
R405	470 k	½ w					302-474
R406	1.5 meg	½ w	Prec.		1%		309-017
R407	1 meg	½ w	Prec.		1%		309-148
R408	470 k	½ w					302-474
R410	47 Ω	¼ w					316-470
R411	100 Ω	¼ w					316-101
R412	27 k	1 w					304-273
R413	4 meg	½ w	Prec.		1%		309-093
R414	2.5 meg	½ w	Prec.		1%		309-025
R415	47 Ω	¼ w					316-470
R416	100 Ω	¼ w					316-101
R417	27 k	1 w					304-273
R418	1 meg	½ w	Prec.		1%		309-148
R419	1.8 meg	½ w	Prec.		1%		309-020
R420	47 Ω	¼ w					316-470
R421	1.4 k	½ w	Prec.		1%		309-274
R423	220 k	¼ w					316-224
R426	1.6 k	½ w			5%		301-162
R427 †	1 k		Var.	WW	GAIN		*311-247
R428	6.8 k	1 w					304-682
R430	120 k	½ w					302-124

† Ganged with SW405. Furnished as a Unit.

							Tektronix Part Number
R432		250 k		Var.		DC Bal.	Use 311-374
R439	X210-up	47 k	½ w				302-473
R440		47 Ω	½ w				302-470
R441		6.2 k	2 w			5%	305-622
R442		1.8 k	½ w	Prec.	Mica Pl.	1%	*310-533
R443		470 k	¼ w				316-474
R444		39 Ω	½ w			5%	301-390
R445		82 Ω	½ w	(Select Nom Val)		5%	301-820
R446		8 k	5 w		WW	5%	308-007
R447	X542-up	5.6 k	1 w				304-562
R450		47 Ω	¼ w				316-470
R451		47 Ω	¼ w				316-470
R452		100 Ω	¼ w				316-101
R454		12 k	1 w				304-123
R456		12 k	1 w				304-123
R458		100 Ω	¼ w				316-101
R460		47 Ω	½ w				302-470
R461		850 Ω	5 w		WW	5%	308-187
R462		2.5 k	5 w	Prec.	Mica Pl.	1%	*310-522
R463		470 k	¼ w				316-474
R466		120 Ω	½ w			5%	301-121
R468		8 k	5 w		WW	5%	308-007
R469		4.7 k	½ w				302-472
R470		3.3 k	½ w				302-332
R471		82 k	½ w				302-823
R472	X400-up	470 k	¼ w				316-474
R474		100 k		Var.		Vertical POSITION	311-026
R478		3.3 k	½ w				302-332
R480		47 Ω	¼ w				316-470
R483		33 k	½ w			5%	301-333
R484		68 k	½ w			5%	301-683
R485		22 k	½ w			5%	301-223
R487		100 k	1 w			5%	303-104
R506		1.5 meg	½ w	Prec.		1%	309-017
R507		1 meg	½ w	Prec.		1%	309-148
R508		470 k	½ w				302-474
R520		47 Ω	¼ w				316-470
R521		1.4 k	½ w	Prec.		1%	309-274
R523		220 k	¼ w				316-224
R526		1.6 k	½ w			5%	301-162
R527		3.5 k	5 w		WW	5%	308-080
R539	X210-up	47 k	½ w				302-473
R540		47 Ω	½ w				302-470
R542		1.8 k	½ w	Prec.	Mica Pl.	1%	*310-533
R543		470 k	¼ w				316-474
R544		39 Ω	½ w			5%	301-390
R546		8 k	5 w		WW	5%	308-007
R547	101-150	3 k	5 w		WW	5%	308-082
R547	151-up	3.5 k	5 w		WW	5%	308-080
R560		47 Ω	½ w				302-470
R562		2.5 k	5 w	Prec.	Mica Pl.	1%	*310-522
R563		470 k	¼ w				316-474
R565	X542-up	1 k	½ w				302-102
R566		120 Ω	½ w			5%	301-121

©

Resistors *(continued)*

							Tektronix Part Number
R567		850 Ω	5 w		WW	±5%	308-187
R570		47 Ω	1/4 w				316-470
R573		15 k	2 w				306-153
R580		47 Ω	1/4 w				316-470
R583		68 k	1/2 w			5%	301-683
R590		27 k	1/2 w				302-273
R591		680 k	1/2 w				302-684
R592		47 Ω	1/4 w				316-470
R593		9.1 k	1/2 w			5%	301-912
R595		5.6 k	1/2 w			5%	301-562
R596		2.7 meg	1/2 w			5%	301-275
R597		27 k	2 w			5%	305-273
R598		47 Ω	1/4 w				316-470
R599		8.2 k	1/2 w			5%	301-822
R601†		50 Ω		Var.	WW	SCALE ILLUM.	311-057
R610		2.7 Ω	1 w				307-007
R611		2.7 Ω	1 w				307-007
R614		4.7 Ω	1 w				307-009
R619		27 k	1 w				304-273
R620		1 meg	1/2 w				302-105
R621		1 k	1/4 w				316-102
R622		36 k	1 w			5%	303-363
R623		1 meg	1/2 w				302-105
R624		1 k	1/4 w				316-102
R625		1 k	1/4 w				316-102
R626		1 k	1 w				304-102
R627	101-150	1.5 k	25 w		WW	5%	308-040
R627	151-up	1.5 k	10 w		WW	5%	308-055
R630		1 meg	1/2 w				302-105
R631		250 k	1/2 w	Prec.		1%	309-162
R632		400 k	1 w	Prec.		1%	310-094
R634		2 meg	1/2 w	Prec.		1%	309-023
R636		100 k		Var.		—140 Volts	311-026
R640		470 k	1/2w				302-474
R650		180 k	1/2 w				302-184
R651		68 k	1/2 w				302-683
R653		1.8 meg	1/2 w				302-185
R654		1 k	1/4 w				316-102
R655		1 k	1/4 w				316-102
R656		1 k	1 w				304-102
R657	101-150	1.5 k	25 w		WW	5%	308-040
R657	151-up	1.5 k	10 w		WW	5%	308-055
R660		470 k	1/2 w				302-474
R661		400 k	1/2 w	Prec.		1%	309-126
R662		390 k	1/2 w	Prec.		1%	309-056
R670		220 k	1/2 w				302-224
R671		39 k	1/2 w				302-393
R672		470 k	1/2 w				302-474
R673		1.8 meg	1/2 w				302-185
R674		1 k	1/4 w				316-102
R675		1 k	1/4 w				316-102

† R601 ganged with SW601. Furnished as a unit.

Resistors *(continued)*

								Tektronix Part Number
R676	101-150	500 Ω	5 w		WW			308-189
R676	151-745X	333 Ω	10 w		WW	5%		308-049
R677	101-150	2.25 k	20 w		WW	5%		308-064
R677	151-745	2 k	25 w		WW	5%		308-065
R677	746-up	2.25 k	20 w		WW	5%		308-064
R678		1 k	1 w					304-102
R679	X151-745	150 Ω	2 w					306-151
R679	746-up	47 k	2 w					306-473
R680		470 k	½ w					302-474
R681		200 k	½ w	Prec.		1%		309-051
R682		400 k	1 w	Prec.		1%		310-094
R803	101-150	47 k	2 w					Use 306-683
R803	151-up	68 k	2 w					306-683
R806	101-150	100 k	½ w					Use 302-473
R806	151-up	47 k	½ w					302-473
R807		5.6 k	½ w					302-562
R808	X190-up	220 Ω	½ w					302-221
R814		1 k	½ w					302-102
R822	X180-up	3.3 Ω	½ w					307-025
R823	X180-up	3.3 Ω	½ w					307-025
R815		470 k	½ w					302-474
R839	X300-up	1.5 meg	½ w					302-155
R840	101-299	3.3 meg	1 w					304-335
R840	300-up	1.5 meg	½ w					302-155
R841		2 meg		Var.		—3800 V		311-042
R842		8.2 meg	2 w					306-825
R843		8.2 meg	2 w					306-825
R844		6.8 meg	2 w					306-685
R845		5 meg		Var.		FOCUS		311-121
R846		4.7 meg	2 w					306-475
R847		680 k	½ w					302-684
R848		2 meg		Var.		INTENSITY		311-043
R850		33 k	½ w					302-333
R851	X151-up	1 meg	½ w					302-105
R860	101-150	2 x 1 k		Var.	WW	CRT Beam Rotator		311-007
R860	151-up	2 x 300 Ω		Var.		CRT Beam Rotator		311-250
R864		50 k		Var.		Astig.		311-023
R866		62 k	½ w			5%		301-623
R867		56 k	½ w			5%		301-563
R871		470 Ω	½ w					302-471
R875		39 k	1 w					304-393
R880		2.5 k	½ w	Prec.		1%		309-181
R882		1 k	½ w	Prec.		1%		309-115
R884		13.5 k	½ w	Prec.		1%		309-263
R886	101-150	10 k		Var.		Cal. Ampl.		311-016
R886	151-up	10 k		Var.	WW	Cal. Ampl.		311-015

Switches

				Unwired	Wired
SW7	101-150	Slide	SYNC	260-212	
	151-up	Slide	SYNC	260-122	
SW160		Rotary	DISPLAY	*260-371	*262-394
SW178	101-150	Red Pushbutton	FIELD SHIFT	260-016	
	151-up	Red Pushbutton	FIELD SHIFT	260-247	
SW335		Rotary	MAGNIFIER	*260-374	*262-393
SW404	101-398	Rotary	INPUT	Use 050-068	
SW404	399-up	Rotary	INPUT	*260-479	*262-517
SW405†		Rotary	GAIN	*260-372	*262-389

† Ganged with R427. Furnished as a unit.

Switches *(continued)*

				Tektronix Part Number	
				Unwired	Wired
SW434	101-331	Rotary	RESPONSE	*260-375	050-053
SW434	332-up	Rotary	RESPONSE	*260-375	*262-443
SW601 ‡			AC OFF	311-057	
SW880		Rotary	CALIBRATOR	*260-373	*262-390

Transformers

T601	Low Voltage	*120-204
T801	High Voltage	*120-206

Transistor

Q874	2N394/2N1303	151-051

Vacuum Tubes

V14	6DJ8	154-187
V24	6EW6	154-212
V35	6DJ8	154-187
V45	6DJ8	154-187
V145	6BA8A	154-163
V152	6BJ8	154-305
V161†	6BL8	154-278
V343	12AU7	154-041
V374	12AU7	154-041
V384	6DJ8	154-187
V413	6DJ8	154-187
V424	6AU6	154-022
V444 ††	6EW6	Use *157-069
V453	6DJ8	154-187
V464	6197	154-146
V484†	6BL8	154-278
V524	6AU6	154-022
V544 ††	6EW6	Use *157-069
V564	6197	154-146
V572	6BJ8	154-305
V582	6BJ8	154-305
V595	6DJ8	154-187
V619	5651	154-052
V626†	6BL8	154-278
V627	6CW5/EL86	154-202
V654	6AU6	154-022
V657	6CW5/EL86	154-202
V677	7734/6GE8	154-260
V800	6CZ5	154-167
V814	12AU7	154-041
V822	5642	154-051
V859	T5270-1 Standard Phosphor CRT	*154-314

‡ SW601 ganged with R601. Furnished as a unit.
†ECF80, 7643/E80CF or 6U8A may be substituted.
†† Furnished as a unit.

Mechanical Parts List
Type RM527

	Tektronix Part Number
BAR, RETAINING ZAMAK #5 1/2 x 2 1/8	381-187
BRACKET, NYLON COAX INSULATING SN X370-up	406-224
BRACKET, SWITCH MTG.	406-670
BRACKET, CRT SHIELD LEFT	406-671
BRACKET, SHIELD RIGHT	406-672
BRACKET, HV TRANSFORMER MTG.	406-673
BRACKET, DELAY LINE	406-678
BRACKET, TRANSFORMER MTG.	406-679
BRACKET, BEAM ROTATOR POT	406-699
BRACKET, PARALLAX ADJUSTING X845-up	406-730
BUSHING, STRAIN RELIEF	358-025
BUSHING, PANEL	358-029
BUSHING, INSULATING SN 101-369X	358-097
BUSHING, INNER SLEEVE .219 ID x 1/4" long	358-111
BUSHING, OUTER SLEEVE w/tab .317 x 1/2" long	358-112
CABLE, HARNESS, SWEEP & POWER SN 101-150	179-497
CABLE, HARNESS, VERTICAL AMP. SN 101-150	179-498
CABLE, HARNESS, F & I	179-499
CABLE, HARNESS, CRT SOCKET	179-515
CABLE, HARNESS, VERTICAL AMP. SN 151-up	179-530
CABLE, HARNESS, SWEEP SN 151-up	179-531
CABLE, HARNESS, BEAM ROTATOR SN 101-150	179-516
CABLE, HARNESS, BEAM ROTATOR SN 150-up	179-532
CAP, FUSE HOLDER	200-015
CAP, POT INSULATING, PLASTIC	200-238
CAP, POT INSULATING, POLYETHELENE	200-247
CHASSIS, RIGHT SN 101-150	441-356
CHASSIS, LEFT SN 101-150	441-357
CHASSIS, RIGHT SN 151-up	441-371
CHASSIS, LEFT SN 151-up	441-372
CLAMP, CABLE 3/16 Plastic	343-002
CLAMP, CABLE 1/4 Plastic	343-003
CLAMP, CABLE 5/16 Plastic	343-004
CLAMP, CABLE 7/16 Plastic	343-005
CLAMP, CABLE 1/2 Plastic	343-006
CLAMP, TUBE BASE w/1 mtg. strap	343-012
CLAMP, CABLE 3/8"	343-013
CLAMP, CRT SN 101-150	343-020

Mechanical Parts List *(continued)*

	Tektronix Part Number
CLAMP, CABLE 5/16 half	343-042
CLAMP, NEON BULB	343-043
CLAMP, CRT 101-844X	343-071
CONNECTOR, POST	129-006
CONNECTOR, CRT	131-059
CONNECTOR, COAX "D" MOUNT (101-369)	131-081
CONNECTOR, CHASSIS MTD. (370-up)	131-064
CORD, POWER	161-017
COUPLING, NYLON INSULATING	376-011
COVER, POT & SWITCH (101-399X)	200-152
COVER, FUSE HOLDER	200-237
COVER, DUST POT 17/32 x 1	200-263
COVER, POT 1.115 dia x 1 5/16 hi.	200-269
COVER, GRATICULE ASSY	use 200-409
EYELET, TAPERED BARREL	210-601
FAN, MUFFIN	use 119-026
FASTENER, PAWL RIGHT w/stop	214-052
FASTENER, PAWL LEFT w/stop	214-053
FELT 17 1/2"	124-142
FILTER, LIGHT	378-525
FOOT, RUBBER, BLACK	348-013
GRATICULE †	331-068
GROMMET, RUBBER 1/4	348-002
GROMMET, RUBBER 5/16	348-003
GROMMET, RUBBER 3/8	348-004
GROMMET, RUBBER 1/2	348-005
GROMMET, RUBBER 3/4	348-006
GROMMET, RUBBER 5/8	348-012
GROMMET, POLYPROPOLENE, snap-in	348-031
HOLDER, DOUBLE NEON	352-006
HOLDER, NYLON SINGLE NEON	352-008
HOLDER, FUSE	352-010
KNOB, BLACK LARGE	366-028
KNOB, BLACK SMALL 1/4 hole part way .780 OD	366-044

† When ordering, please specify if a + or — 7.5% tolerance marking is desired.

Mechanical Parts List *(continued)*

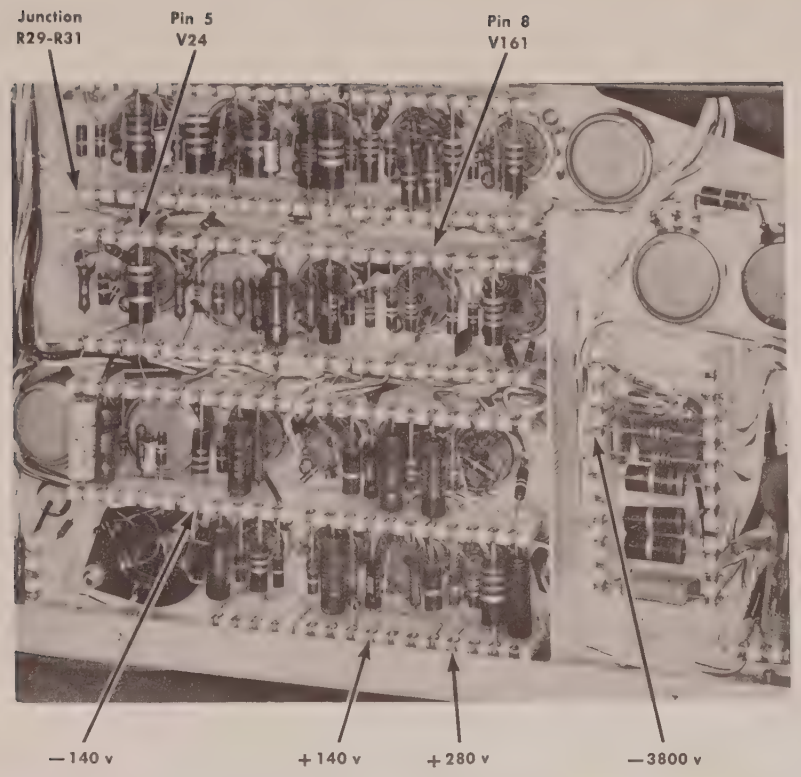
	Tektronix Part Number
LOCKWASHER #4 INT	210-004
LOCKWASHER #6 INT	210-006
LOCKWASHER #8 INT	210-008
LOCKWASHER #10 INT	210-010
LOCKWASHER POT INT	210-012
LOCKWASHER $\frac{3}{8} \times \frac{11}{16}$ INT	210-013
LUG, SOLDER, SE4	210-201
LUG, SOLDER, SE6 w/2 wire holes	210-202
LUG, SOLDER, DE6	210-204
LUG, SOLDER, SE8	210-205
LUG, SOLDER, SE10	210-206
LUG, SOLDER, POT PLAIN	210-207
LUG, SOLDER, SE10 (370-up)	210-224
LUG, GROUND, $\frac{15}{16}$ long	210-241
NUT, HEX 4-40 x $\frac{3}{16}$	210-406
NUT, HEX 6-32 x $\frac{1}{4}$	210-407
NUT, HEX $\frac{3}{8}$-32 x $\frac{1}{2}$	210-413
NUT, GARTICULE (101-509)	210-434
NUT, GRATICULE (510-up)	210-571
NUT, KEPS 6-32 x $\frac{5}{16}$	210-457
NUT, KEPS 8-32 x $\frac{11}{32}$	210-458
NUT, HEX 6-32 x $\frac{1}{2}$ x $\frac{23}{64}$, 25 w resistor mtg.	210-462
NUT, HEX 6-32 x $\frac{5}{16}$ x .194, 5-10 w resistor mtg.	210-478
NUT, SQUARE 10-32 x $\frac{3}{8}$	210-501
NUT, HEX 10-32 x $\frac{3}{8}$ x $\frac{1}{8}$	210-564
NUT, CAPTIVE, FLOATING 6-32	210-566
NUT, ADJUST SECURING W/2 HOLES TAPPED 6-32	214-207
PANEL, FRONT (101-150)	333-636
PANEL, FRONT (151-up)	333-653
PLATE, TRANSFORMER	386-645
PLATE, BACK, CRT SOCKET .020 thick x $2\frac{3}{32}$ OD	387-344
PLATE, DUST COVER, TOP & BOTTOM	387-361
PLATE, SIDE LEFT	387-362
PLATE, SIDE RIGHT	387-363
PLATE, SUBPANEL, FRONT (101-150)	387-364
PLATE, SUBPANEL, FRONT (151-up)	387-403
PLATE, REAR (101-150)	387-365
PLATE, BULK HEAD (101-150)	387-366
PLATE, BOTTOM COVER	387-392
PLATE, BULK HEAD (151-up)	387-401
PLATE, REAR (151-369)	387-402
PLATE, REAR (370-up)	387-623

	Tektronix Part Number
PLATE, COAX MOUNTING (101-398)	Use 050-068
PLATE, COAX MOUNTING (399-up)	388-530
RING, CRT SOCKET, FIBER	354-049
RING, CAPACITOR SECURING	354-068
RING, CLAMPING, Delrin 1/2 x 2 1/4 w/2 ears	354-147
ROD, SHAFT EXT. 1/4 dia. alum. x 8 3/4 lg.	384-581
ROD, SHAFT EXT. 1/4 dia. alum. x 4 15/16 lg.	384-582
ROD, NYLON 5/16 x 1 5/32 TAPPED 6-32 both ends	385-017
ROD, ALUM., Hex 3/8 x 1/4 x 6-32 tapped thru (399-up)	385-079
ROD, ALUM., 1/4 x 3 3/16 tapped 6-32 both ends,	385-029
ROD, NYLON, 5/16 x 1 5/8 tapped 6-32 one end,	385-085
ROD, NYLON, 5/16 dia. x 2 9/16 lg. D&T 6-32 x 3/8 both ends	385-151
SCREW 4-40 x 5/16 BHS	211-011
SCREW 4-40 x 3/8 BHS (370-up)	211-012
SCREW 4-40 x 1/4 FHS	211-023
SCREW 4-40 x 1 FHS	211-031
SCREW 4-40 x 5/16 Pan HS w/lockwasher	211-033
SCREW 4-40 x 5/16 FHS Phillips	211-038
SCREW 6-32 x 3/16 FHS	211-502
SCREW 6-32 x 3/16 BHS	211-503
SCREW 6-32 x 1/4 BHS	211-504
SCREW 6-32 x 5/16 BHS	211-507
SCREW 6-32 x 3/8 BHS	211-510
SCREW 6-32 x 1/2 BHS	211-511
SCREW 6-32 x 5/8 BHS	211-513
SCREW 6-32 x 1 1/4 RHS	211-520
SCREW 6-32 x 5/16 Pan HS w/lockwasher	211-534
SCREW 6-32 x 5/16 FHS 100° Phillips CSK	211-538
SCREW 6-32 x 3/4 Truss HS Phillips	211-544
SCREW 6-32 x 1 1/2 RHS Phillips	211-553
SCREW 6-32 x 1 RHS	211-560
SCREW 6-32 x 7/8 Socket Head Cap	211-576
SCREW 8-32 x 15/16 BHS	212-004
SCREW 8-32 x 3/8 BHS	212-023
SCREW 8-32 x 3/8 FHS	212-024
SCREW 8-32 x 1 3/4 FHS	212-037
SCREW 8-32 x 5/16 FHS Phillips	212-070
SCREW 10-32 x 1/2 BHS	212-508
SCREW 10-32 x 2 3/4 HHS	212-523
SCREW 10-32 x 7/8 RHS	212-548
SCREW, THREAD CUTTING 4-40 x 5/16 RHS Phillips	213-034

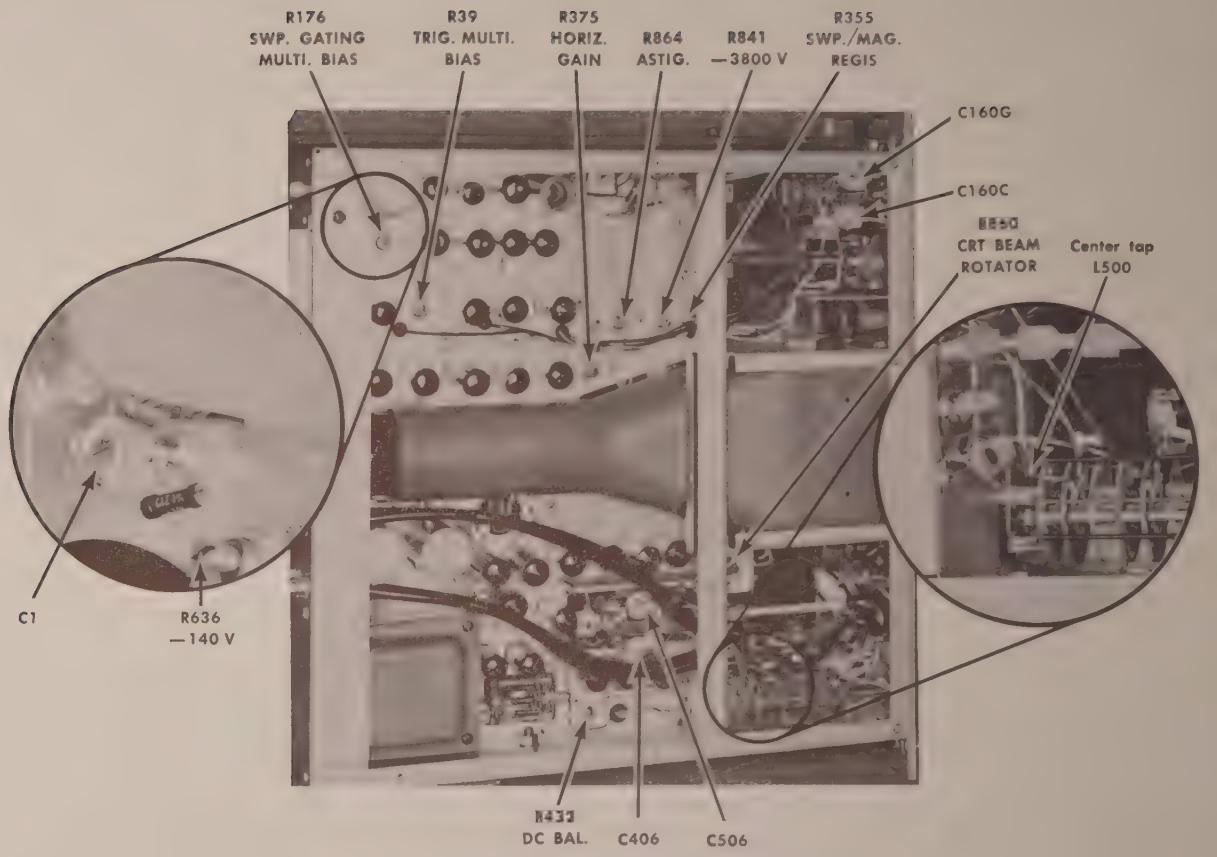
Mechanical Parts List *(continued)*

	Tektronix Part Number
SCREW, THREAD CUTTING 4-40 x 1/4 PHS Phillips	213-035
SCREW, THREAD CUTTING 5-32 x 3/16 Pan HS Phillips	213-044
SCREW, THREAD CUTTING 6-32 x 5/16 PHS Phillips	213-054
SCREW, CAD. PLATED 10-32 x 1/2	213-090
SHIELD, TUBE BASE	337-005
SHIELD, TUBE	337-009
SHIELD, CRT	337-405
SHIELD, VERTICAL SWITCH	337-412
SHIELD, HIGH VOLTAGE	337-413
SHIELD,FOCUS & INTENSITY	337-415
SHIELD, GAIN SWITCH	337-416
SHIELD, VERTICAL SWITCH, UPPER	337-417
SHIELD, FAN HOUSING	337-418
SLIDE, CHASSIS TRAK, 1 pr., left and right	351-040
SOCKET, GRATICULE LIGHT	136-001
SOCKET, STM7G	136-008
SOCKET, STM9G	136-015
SOCKET, 7-pin tube w/1 1/8 dia. mtg. holes	136-044
SOCKET, CRT 9-pin	136-104
SPACER, NYLON 1/16" for Ceramic Strip	361-007
SPACER, NYLON 1/4" for Ceramic Strip	361-008
SPACER, NYLON 3/8" for Ceramic Strip	361-009
SPACER, ALUM.	361-011
SPACER, .180 ID x 1/4 OD x 1/4 lg.	166-031
STRAP, PLASTIC TIE	346-023
STRIP, CERAMIC 3/4 x 2 notches, clip mounted	124-086
STRIP, CERAMIC 3/4 x 3 notches, clip mounted	124-087
STRIP, CERAMIC 3/4 x 4 notches, clip mounted	124-088
STRIP, CERAMIC 3/4 x 7 notches, clip mounted	124-089
STRIP, CERAMIC 3/4 x 9 notches, clip mounted	124-090
STRIP, CERAMIC 3/4 x 11 notches, clip mounted	124-091
STRIP, CERAMIC 3/4 x 1 notches, clip mounted	124-100
TAG, VOLTAGE	334-649
TAG, SERIAL NUMBER	334-679
TUBING, #7 BLACK PLASTIC	162-013
TUBING, #14 BLACK PLASTIC	162-016
TUBING, #20 BLACK PLASTIC	162-504
WASHER, 6L x 3/8 x .032	210-803

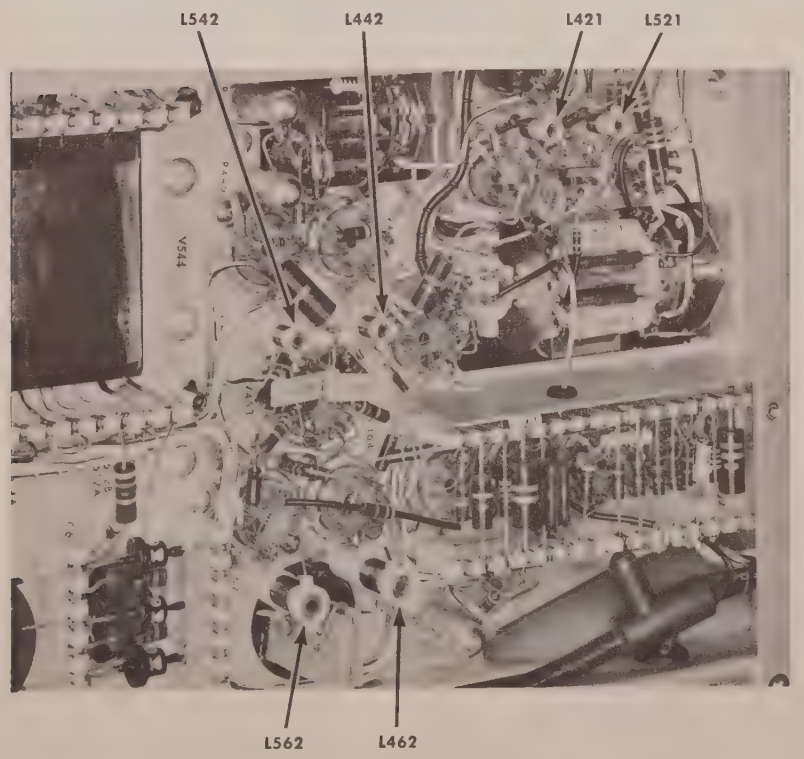
	Tektronix Part Number
WASHER, 8S x 3/8 x .032	210-804
WASHER, 10S x 7/16 x .036	210-805
WASHER, CENTERING 20w resistor	210-808
WASHER, CENTERING 25w resistor	210-809
WASHER, FIBER #10 (370-up)	210-812
WASHER, .390 ID x 9/16 OD x .020	210-840
WASHER, NEOPRENE 7/32 ID x 3/8 OD x .050	210-844
WASHER, RUBBER	210-873
WASHER, STEEL 3/16 ID x 3/8 OD x .050	210-864
WASHER, BRASS 1/16 x 9/64 ID x 1/2 OD	210-949



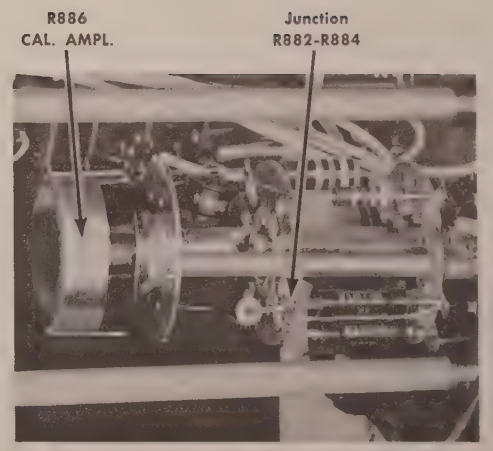
Test points, bottom view, rear.



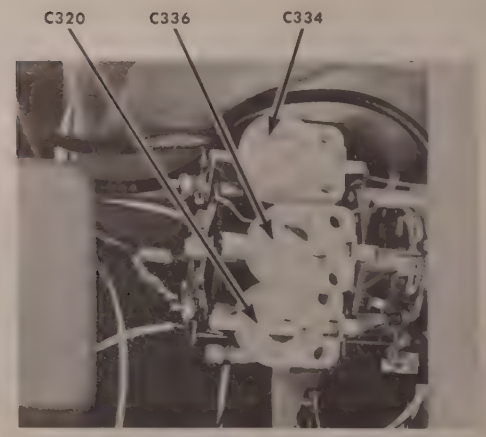
Internal adjustments, top view.



Variable inductors, bottom view, rear.

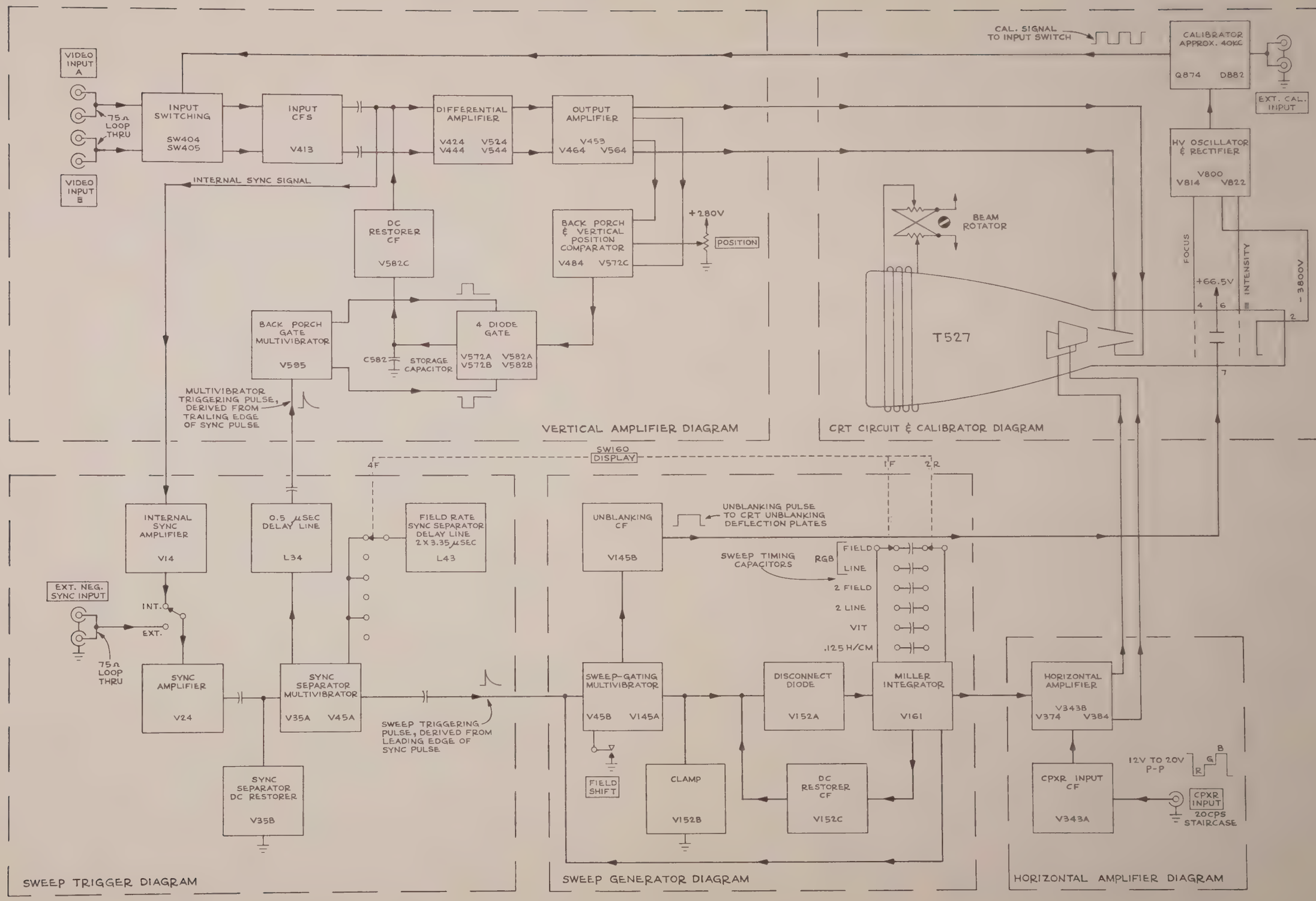


Calibrator switch, bottom view, front.



Magnifier adjustments, bottom view, front.

Type RM527 test points and adjustments.

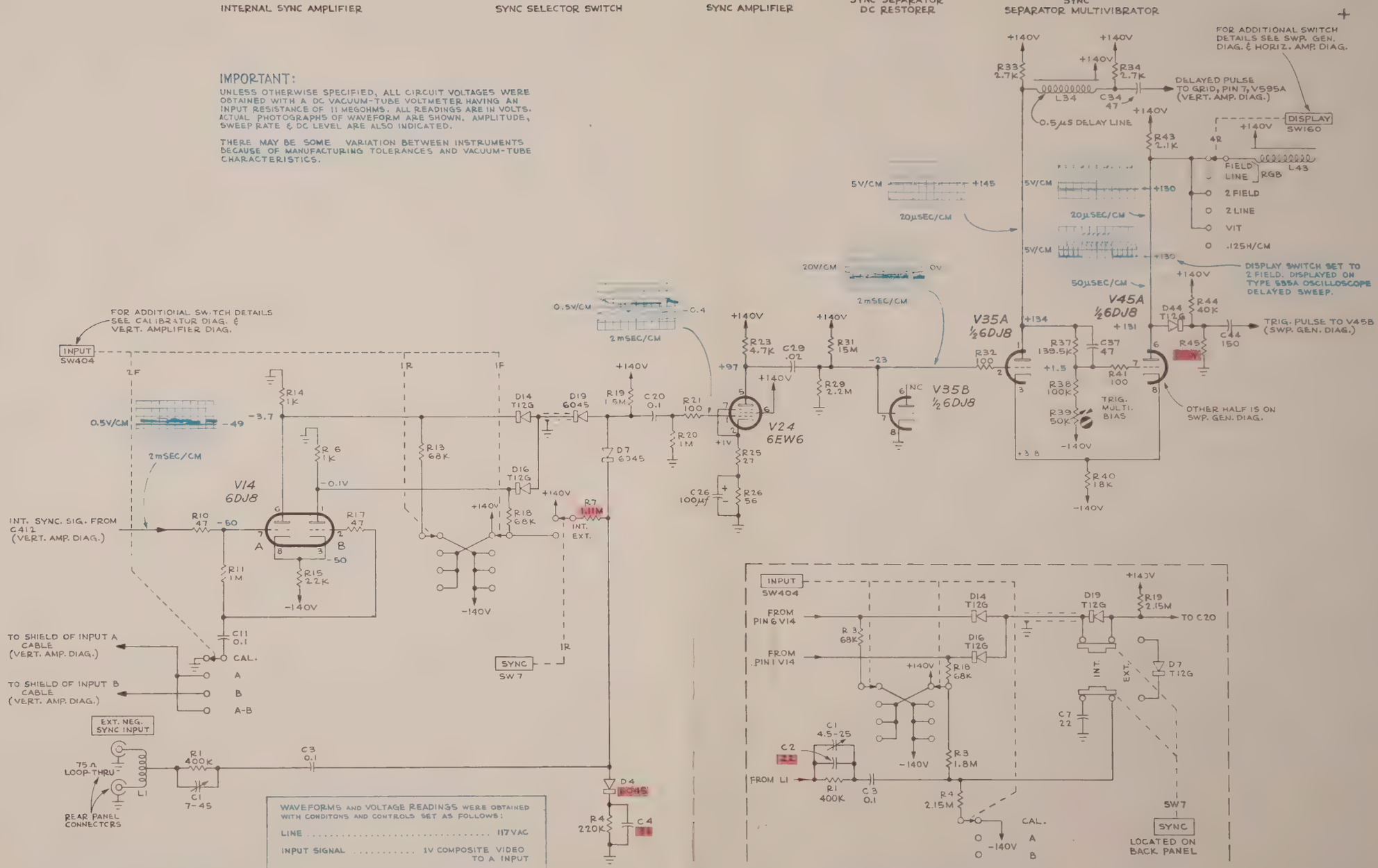

VIDEO INPUT A
VIDEO INPUT B
75Ω LOOP THRU
INPUT SWITCHING
SW404 SW405
INPUT CFS
V413
DIFFERENTIAL AMPLIFIER
V424 V524
V444 V544
OUTPUT AMPLIFIER
V453
V464 V564
INTERNAL SYNC SIGNAL
DC RESTORER CF
V582C
BACK PORCH & VERTICAL POSITION COMPARATOR
V484 V572C
+280V
POSITION
BACK PORCH GATE MULTIVIBRATOR
V595
4 DIODE GATE
V572A V582A
V572B V582B
C582 STORAGE CAPACITOR
MULTIVIBRATOR TRIGGERING PULSE, DERIVED FROM TRAILING EDGE OF SYNC PULSE
VERTICAL AMPLIFIER DIAGRAM
CAL. SIGNAL TO INPUT SWITCH
CALIBRATOR APPROX. 40KC
Q874 D882
EXT. CAL. INPUT
HV OSCILLATOR & RECTIFIER
V800
V814 V822
BEAM ROTATOR
T527
FOCUS
INTENSITY
+66.5V
-3800V
4
6
2
7
CRT CIRCUIT & CALIBRATOR DIAGRAM
SW160 DISPLAY
4F
1F
2R
INTERNAL SYNC AMPLIFIER
V14
0.5 μSEC DELAY LINE
L34
FIELD RATE SYNC SEPARATOR DELAY LINE 2X3.35 μSEC
L43
UNBLANKING CF
V145B
UNBLANKING PULSE TO CRT UNBLANKING DEFLECTION PLATES
SWEEP TIMING CAPACITORS
RGB
FIELD
LINE
2 FIELD
2 LINE
VIT
.125 H/CM
EXT. NEG. SYNC INPUT
INT.
EXT.
75Ω LOOP THRU
SYNC AMPLIFIER
V24
SYNC SEPARATOR MULTIVIBRATOR
V35A V45A
SYNC SEPARATOR DC RESTORER
V35B
SWEEP TRIGGERING PULSE, DERIVED FROM LEADING EDGE OF SYNC PULSE
SWEEP-GATING MULTIVIBRATOR
V45B V145A
FIELD SHIFT
CLAMP
V152B
DISCONNECT DIODE
V152A
DC RESTORER CF
V152C
MILLER INTEGRATOR
V161
HORIZONTAL AMPLIFIER
V343B
V374 V384
12V TO 20V P-P
B
G
R
CPXR INPUT CF
V343A
CPXR INPUT 20CPS STAIRCASE
SWEEP TRIGGER DIAGRAM
SWEEP GENERATOR DIAGRAM
HORIZONTAL AMPLIFIER DIAGRAM

INTERNAL SYNC AMPLIFIER | SYNC SELECTOR SWITCH | SYNC AMPLIFIER | SYNC SEPARATOR DC RESTORER | SYNC SEPARATOR MULTIVIBRATOR

IMPORTANT:

UNLESS OTHERWISE SPECIFIED, ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A DC VACUUM-TUBE VOLTMETER HAVING AN INPUT RESISTANCE OF 11 MEGOHMS. ALL READINGS ARE IN VOLTS. ACTUAL PHOTOGRAPHS OF WAVEFORM ARE SHOWN. AMPLITUDE, SWEEP RATE & DC LEVEL ARE ALSO INDICATED.

THERE MAY BE SOME VARIATION BETWEEN INSTRUMENTS BECAUSE OF MANUFACTURING TOLERANCES AND VACUUM-TUBE CHARACTERISTICS.



WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONDITONS AND CONTROLS SET AS FOLLOWS:

LINE	117VAC
INPUT SIGNAL	1V COMPOSITE VIDEO TO A INPUT
INPUT SELECTOR	(FOR WAVEFORMS) A (FOR VOLTAGE READINGS) CAL.
CALIBRATOR	.714
GAIN	HIGH, CCW
VERTICAL POSITION	MIDRANGE
DISPLAY	.125H/CM
INT.-EXT. SYNC.	INT.
RESPONSE	IRE

SEE ALSO NOTE ON THIS DIAGRAM

527 A SWP. TRIG.

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

TYPE RM 527 WAVEFORM MONITOR

CIRCUIT NUMBERS 1 THRU 45

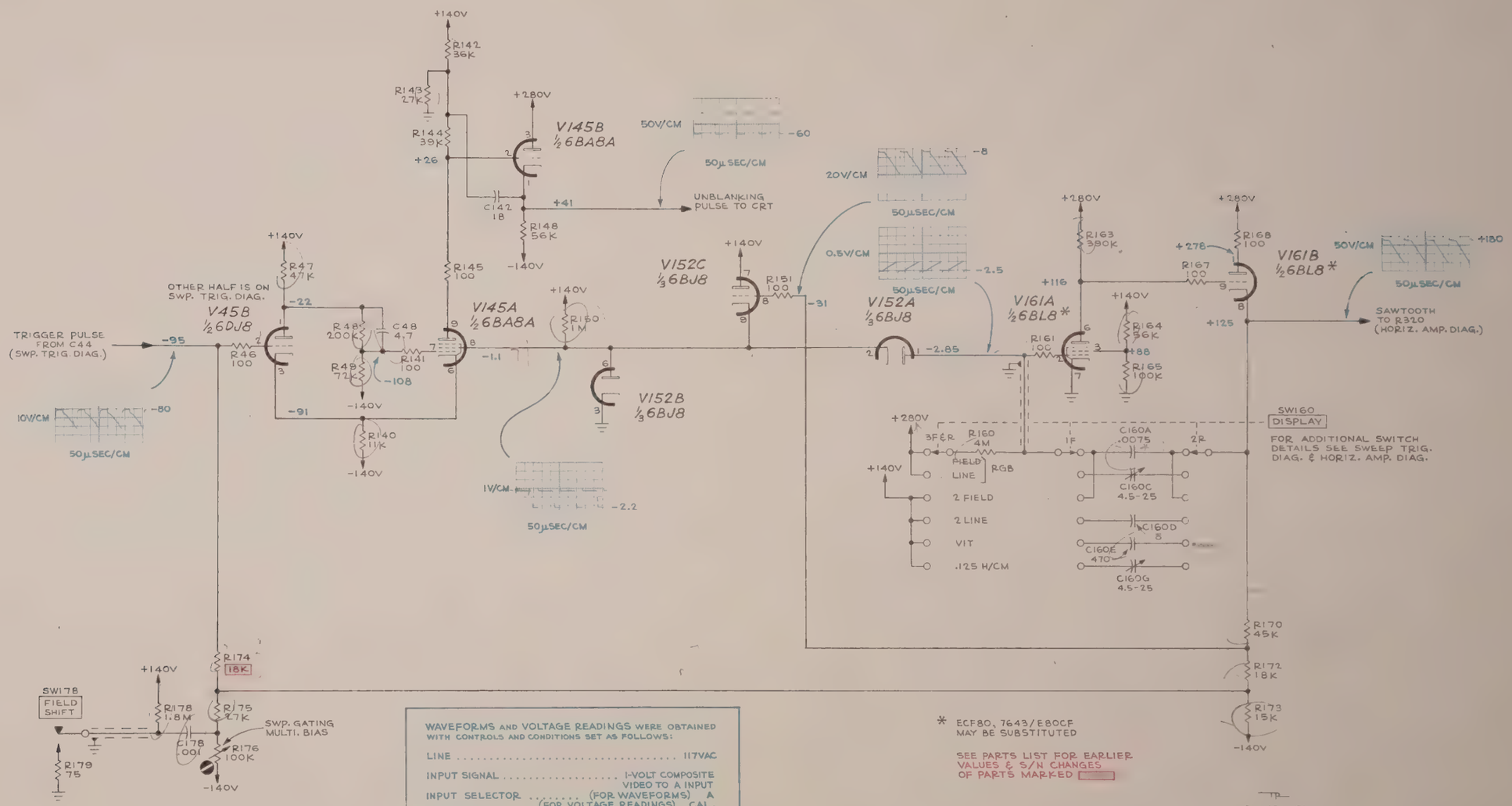
02-22-62

A2

SWEEP TRIGGER

SWEEP TRIGGER

SWEEP-GATING MULTIVIBRATOR UNBLANKING CF CLAMP DC RESTORER CF DISCONNECT DIODE MILLER INTEGRATOR



WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONTROLS AND CONDITIONS SET AS FOLLOWS:

LINE	117VAC
INPUT SIGNAL	1-VOLT COMPOSITE VIDEO TO A INPUT
INPUT SELECTOR (FOR WAVEFORMS)	A
(FOR VOLTAGE READINGS)	CAL.
CALIBRATOR	.714
RESPONSE	IRE
GAIN	HIGH, CCW
VERTICAL POSITION	MIDRANGE
INT.-EXT. SYNC.	INT.
DISPLAY	.125H/CM

SEE ALSO NOTE ON SWEEP TRIGGER DIAGRAM.

527 A SWP. GEN.

* ECF80, 7643/E80CF MAY BE SUBSTITUTED

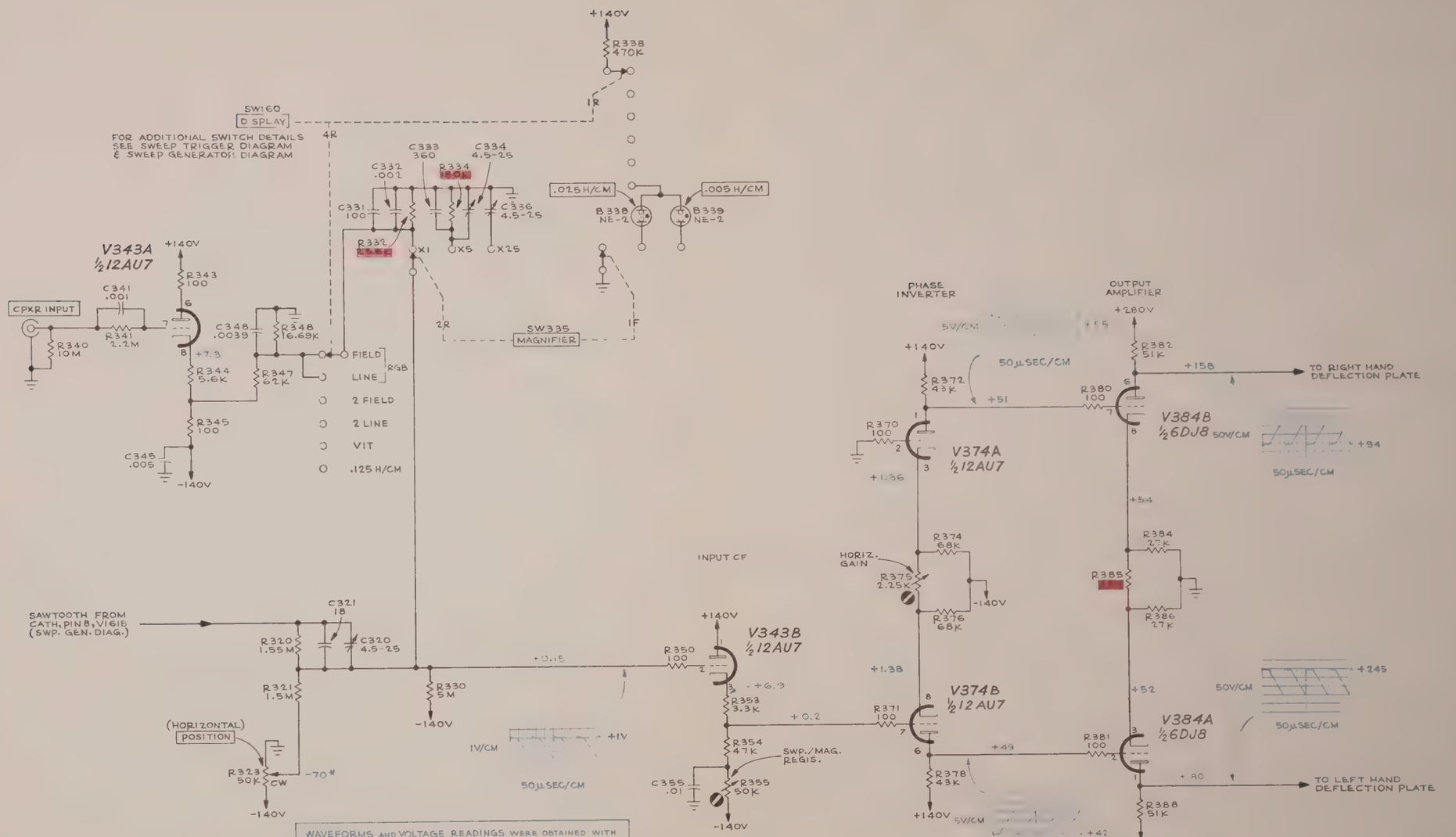
SEE PARTS LIST FOR EARLIER VALUES & S/N CHANGES OF PARTS MARKED

CIRCUIT NUMBERS 140 THRU 179

ALSO: V45B, C48, R46, R47, R48, R49

TP
2 - 16 - 61

TYPE RM 527 WAVEFORM MONITOR A SWEEP GENERATOR



WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONTROLS AND CONDITIONS SET AS FOLLOWS:

LINE VOLTAGE	117VAC
INPUT SIGNAL	1-VOLT COMPOSITE VIDEO TO A INPUT
INPUT SELECTOR	(FOR WAVEFORMS) A (FOR VOLTAGES) CAL.
CALIBRATOR	.714
GAIN	HIGH, CCW
HORIZONTAL POSITION	MIDRANGE, SET FOR -70*
MAGNIFIER	X1
DISPLAY	.125H/CM
INT.-EXT. SYNC.	.INT

SEE ALSO NOTE ON SWEEP TRIGGER DIAGRAM

527 A HORIZ. AMP. C

11-01-60

CIRCUIT NUMBERS 320 THRU 388

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

HORIZONTAL AMPLIFIER

TYPE RM 527 WAVEFORM MONITOR

WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONDITIONS AND CONTROLS SET AS FOLLOWS:

LINE	117VAC
INPUT SIGNAL	1V COMPOSITE VIDEO TO A INPUT.
INPUT SELECTOR	(FOR WAVEFORMS) A (FOR VOLTAGE READINGS) CAL.
CALIBRATOR	.714
RESPONSE	IRE
GAIN	HIGH, CCW
VERTICAL POSITION	MIDRANGE
INT.-EXT. SYNC.	INT.

SEE ALSO NOTE ON SWEEP TRIGGER DIAGRAM

527 A VERT. AMP

FROM DELAY LINE L34 (SWEEP TRIG. DIAG.)

INT. TRIG. SIG. TO V14 (SWP. TRIG. DIAG.)

CAL. SIGNAL FROM SW880 (CALIBRATOR DIAG.)

VIDEO INPUT A

VIDEO INPUT B

REAR PANEL CONN.

75Ω LOOP-THRU

SW404 INPUT

SW405 GAIN

GANGED CONTROLS

SW434 RESPONSE

TO SW404-2F (SWP. TRIG. DIAG.)

TO LOWER DEFLECTION PLATE

TO UPPER DEFLECTION PLATE

SELECTED (NOMINAL VALUE 82Ω.)

(VERTICAL) POSITION

GROUND POINTS ON SWITCH MAY BE UNSOLDERED IF SHIELDS OF INPUT COAX SHOULD BE UNGROUNDED.

*ERROR CAUSED BY VTVM

*ECF80 OR 7643/E80CF MAY BE SUBSTITUTED.

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

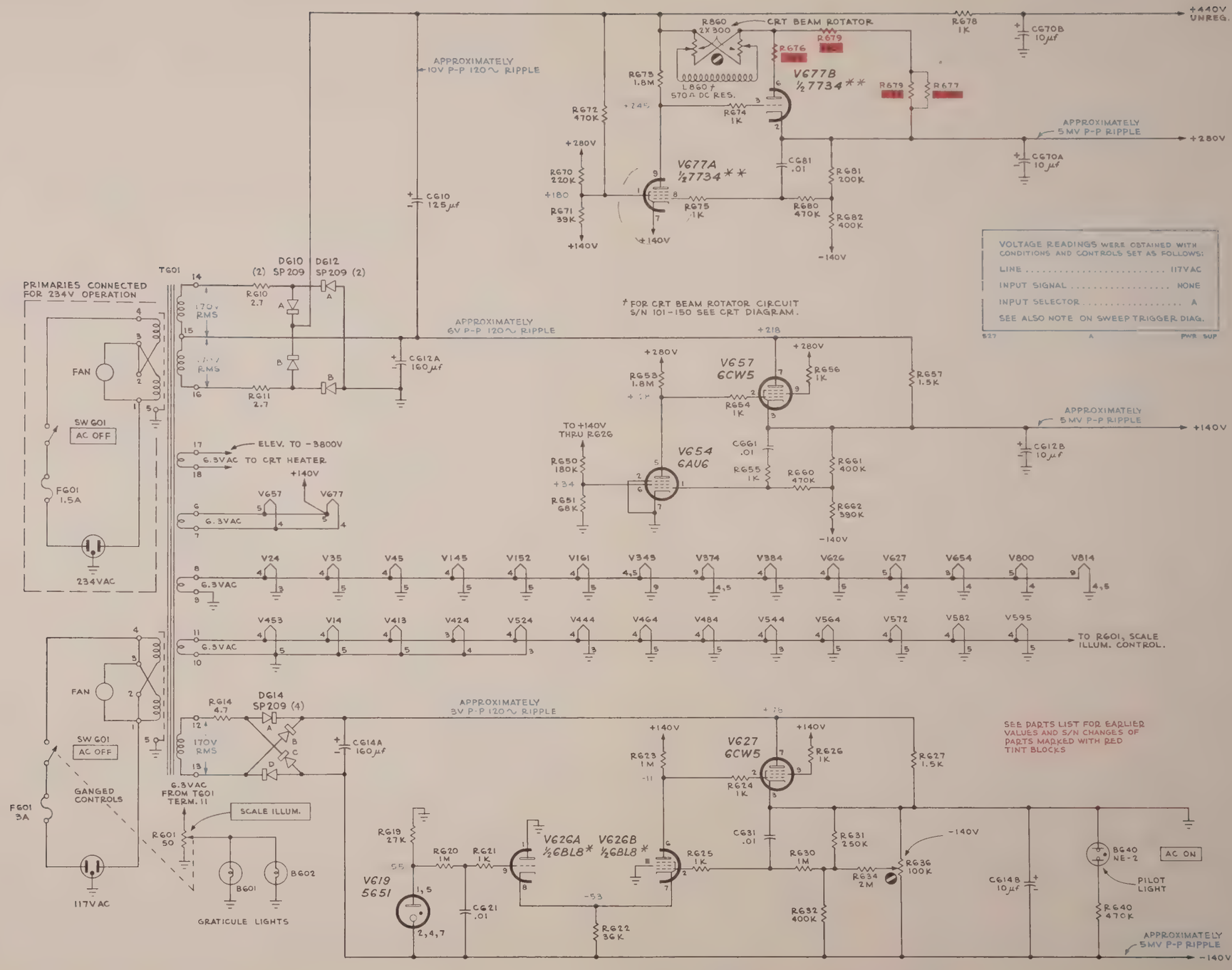
CIRCUIT NUMBERS 400 THRU 599

MRH 02-22-62

TYPE RM 527 WAVEFORM MONITOR

VERTICAL AMPLIFIER

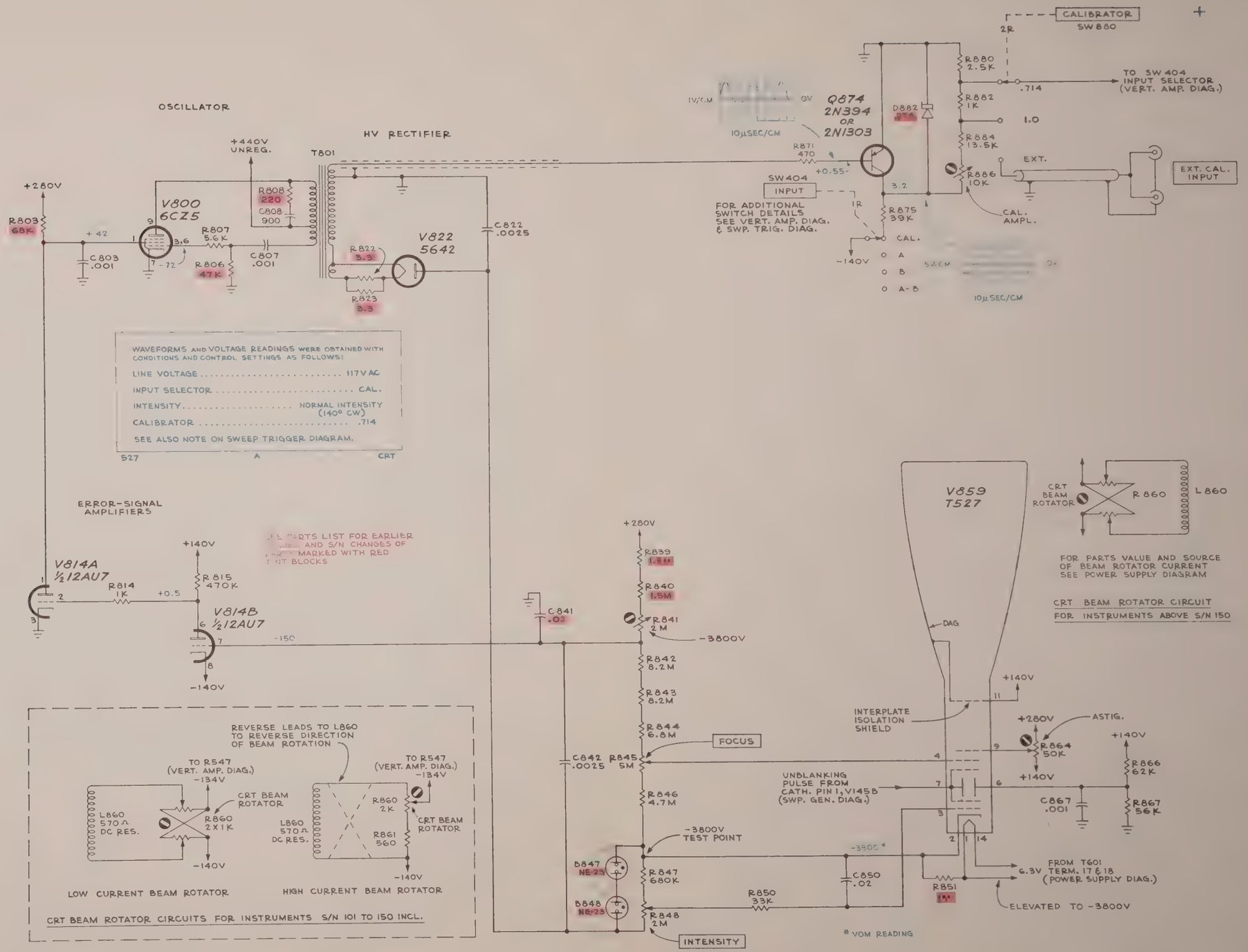
VERTICAL AMPLIFIER



TYPE RM 527 WAVEFORM MONITOR

B

POWER SUPPLY


OSCILLATOR
HV RECTIFIER
+440V UNREG.
T801
+280V
R803 68K
V800 6CZ5
+42
C803 .001
R807 5.6K
R808 220
C808 900
C807 .001
-72
R806 47K
V822 5642
R822 3.3
R823 3.3
C822 .0025
WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONDITIONS AND CONTROL SETTINGS AS FOLLOWS:
LINE VOLTAGE ..... 117V AC
INPUT SELECTOR ..... CAL.
INTENSITY ..... NORMAL INTENSITY (140° CW)
CALIBRATOR ..... .714
SEE ALSO NOTE ON SWEEP TRIGGER DIAGRAM.
527 A CRT
Q874 2N394 OR 2N1303
10μSEC/CM
R871 470
+0.55
SW404 INPUT
FOR ADDITIONAL SWITCH DETAILS SEE VERT. AMP. DIAG. & SWP. TRIG. DIAG.
CALIBRATOR SW880
2R
R880 2.5K
TO SW 404 INPUT SELECTOR (VERT. AMP. DIAG.)
.714
D882
R882 1K
1.0
R884 13.5K
EXT.
EXT. CAL. INPUT
R886 10K
CAL. AMPL.
3.2
1R
R875 39K
CAL.
-140V
A
B
A-B
10μ SEC/CM
ERROR-SIGNAL AMPLIFIERS
+140V
V814A ½12AU7
R814 1K
+0.5
R815 470K
V814B ½12AU7
-150
-140V
C841 .02
+280V
R839 1.5M
R840 1.5M
R841 2M
-3800V
R842 8.2M
R843 8.2M
R844 6.8M
FOCUS
C842 .0025
R845 5M
R846 4.7M
-3800V TEST POINT
D847 NE-23
D848 NE-23
R847 680K
R850 33K
C850 .02
R848 2M
INTENSITY
V859 T527
DAG
INTERPLATE ISOLATION SHIELD
+140V
+280V
ASTIG.
R864 50K
+140V
R866 62K
UNBLANKING PULSE FROM CATH. PIN 1, V145B (SWP. GEN. DIAG.)
C867 .001
R867 56K
-3800V *
FROM T601 6.3V TERM. 17 & 18 (POWER SUPPLY DIAG.)
R851
ELEVATED TO -3800V
* VOM READING
CRT BEAM ROTATOR
R 860
L 860
FOR PARTS VALUE AND SOURCE OF BEAM ROTATOR CURRENT SEE POWER SUPPLY DIAGRAM
CRT BEAM ROTATOR CIRCUIT FOR INSTRUMENTS ABOVE S/N 150
REVERSE LEADS TO L860 TO REVERSE DIRECTION OF BEAM ROTATION
TO R547 (VERT. AMP. DIAG.) -134V
CRT BEAM ROTATOR
L860 570Ω DC RES.
R860 2X1K
-140V
TO R547 (VERT. AMP. DIAG.) -134V
R860 2K
CRT BEAM ROTATOR
L860 570Ω DC RES.
R861 560
-140V
LOW CURRENT BEAM ROTATOR
HIGH CURRENT BEAM ROTATOR
CRT BEAM ROTATOR CIRCUITS FOR INSTRUMENTS S/N 101 TO 150 INCL.
CIRCUIT NUMBERS 800 THRU 886
GAD
7-27-61

MANUAL CHANGE INFORMATION

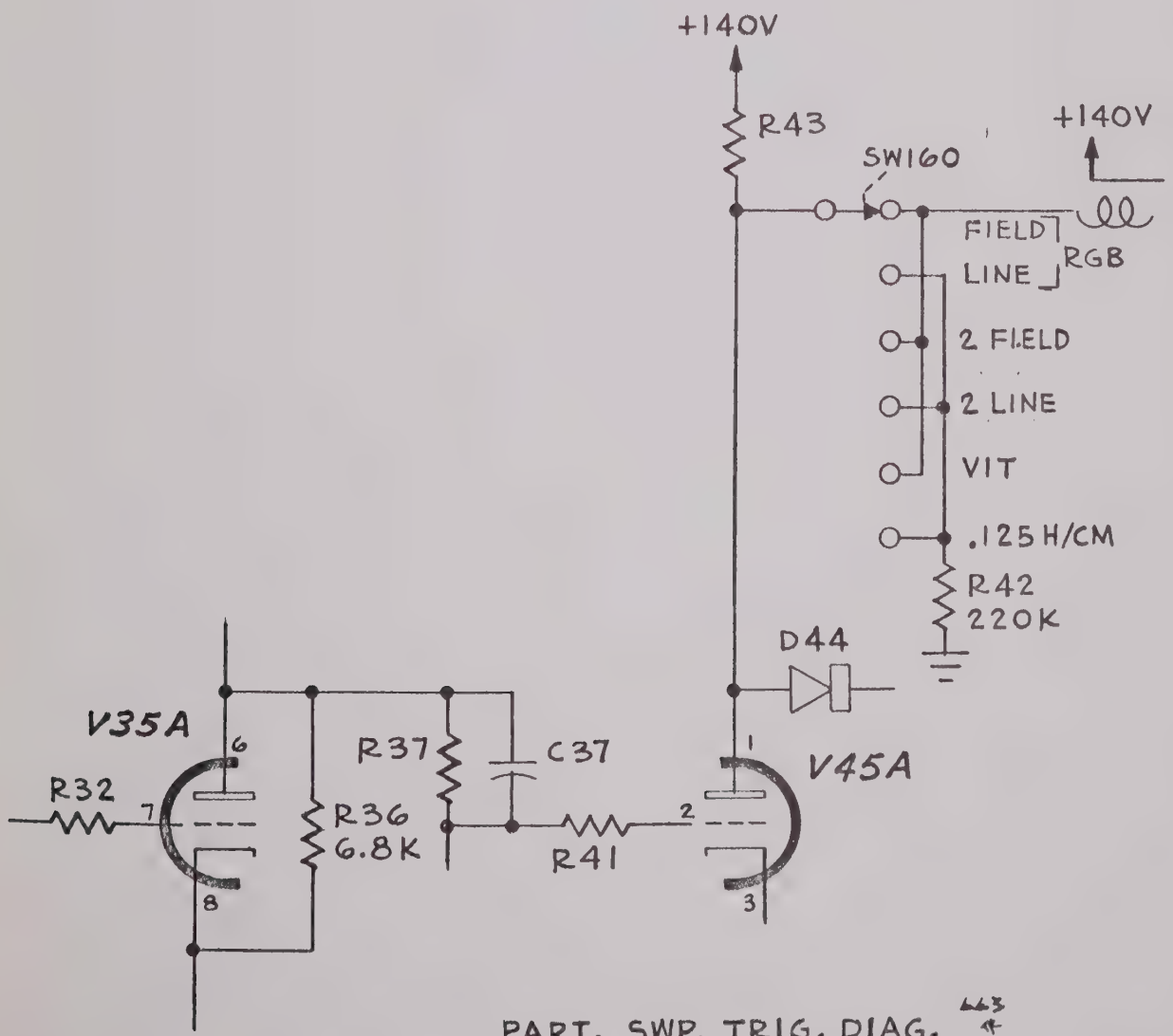
At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 527, RM527
Type 527 - MOD 7112 - Tent S/N 580
Type RM527 - MOD 7112 - Tent S/N 980

SW160	Change to				262-581
R36	Add	6.8k	1/2w	10%	302-682
R42	Add	220k	1/2w	10%	302-224
R166	Add	56k	1/2w	10%	302-563
R432	Change to	250k	Pot, linear	20%	311-374
C348	Change to	.0033μf	Discap	5%	283-051

As per Schematic attached.



PART. SWP. TRIG. DIAG. 443

Mod 6917
TYPE 527 Tent S/N 580
TYPE RM527 Tent S/N 980

R38	Change to	111K	1/2w	1%	309-046

TYPE 527
MOD 6436 - Tent S/N 430 (13)

R432	Change to	250k	Pot.	Double end	311-373

TYPE 527 - TENT. S/N 630
TYPE RM527 - TENT. S/N 1050

PARTS LIST CORRECTIONS

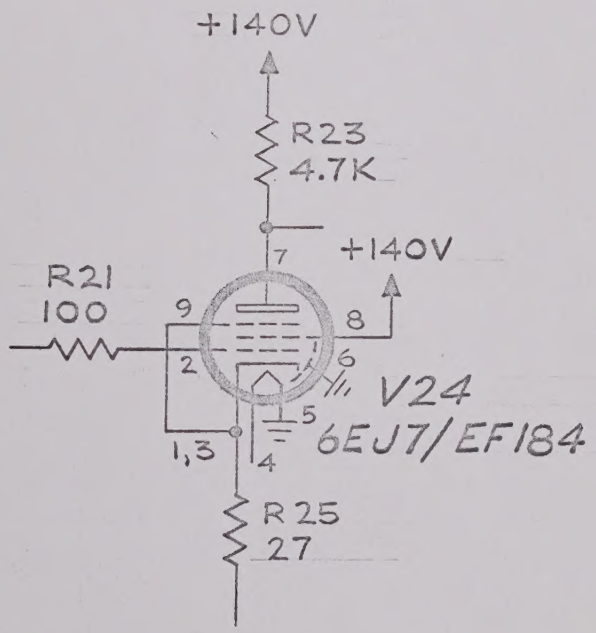
REMOVE

R174	18k	1/4w			316-183

CHANGE TO:

L43	Delay Line				119-027
R43	6.8k	1/2w		5%	301-682
R44	120k	1/2w	Prec.	1%	309-091
R45	500k	1/2w	Prec.	1%	309-003
V24	6EJ7/EF184				154-421

SCHEMATIC CORRECTION



527 PART. SWEEP TRIG.

M7168/868